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PENICILLIN AND TYROTHRICIN IN OTOLARYNGOLOGY

BASED ON A BACTERIOLOGICAL AND CLINICAL STUDY OF 118 PATIENTS

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The treatment of infection is one of the major problems of otolaryngology. Surgical operation for chronic sinusitis is often not successful due to wound infection, which in turn is followed by the formation of excessive granulations, polyps and edema, all of which interfere with drainage and prevent a cure. That the surgeon is becoming more and more awake to the consequences of wound infection is evidenced by the widespread use of the sulfonamide powders. This has proved to be a valuable therapeutic measure. When local application of these powders does succeed in preventing wound infection the patient is far more comfortable, having almost no pain, swelling or suppuration and not needing frequent or painful dressings. The period of hospitalization is shortened for the patient and time and energy saved for the physician.

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The local use of sulfonamide powders has certain disadvantages however. They are poorly absorbed, tend to form crusts which impair drainage, and not infrequently sensitize the patient to a degree that interferes with the use of these drugs by mouth should they be needed, even several years later, in a serious illness. Also many bacteria, commonly found in acute and chronic infections of the upper air passages, are so resistant that sulfonamides in any form are of no value.

Acute infections of the ears and accessory nasal sinuses are commonly due to the pneumococcus or the beta hemolytic streptococcus, but more often than we realize the primary cause is an anaerobe or some other sulfonamide-resistant organism. One of the reasons why some acute infections do not clear up with the usual treatment (rest in bed, local application of heat, measures to promote drainage and when necessary, the sulfonamides by mouth) is the failure of the clinician to make routine aerobic and anaerobic cultures. How can we treat an infection successfully with these drugs if we do not know what organism we have to combat or its sensitivity to sulfonamides or other antibacterial substances we may be using? By failure in successfully treating an infection we do not imply loss of life, but rather the unintelligent use of antibacterial drugs. The sulfonamides given either locally or by mouth are of no value in infections due to the anaerobic streptococcus or any other sulfonamide-resistant organism. Tyrothricin and penicillin also have a selective action, as shown in Tables 1-4, and must be used with discrimination.

As the infection becomes chronic other organisms appear, such as the staphylococcus, Escherichia coli, Proteus, pyocyaneus (Pseudomonas aeruginosa), Friedländer's bacillus and occasionally Haemophilus influenzae. Many of these are so resistant to sulfonamide powders, tyrothricin or penicillin that no decrease of suppuration follows their use. Even when the infecting bacteria are known to be sensitive to a drug, the local use of that drug by irrigation or insufflation in powdered form may have little or no effect on the amount of discharge. Much depends on the accessibility of the infecting bacteria to the action of the drug. In chronic mucous membrane infections the organisms are deeply embedded in the tissues and therefore are not exposed to the killing effect of drugs, such as sulfonamide powder or tyrothricin, which are poorly soluble and do not penetrate. Penicillin on the other hand is perfectly soluble in water, does penetrate the tissues, is a powerful germicide for certain organisms (Tables 1-4) and is not toxic.

For these reasons it is the best of the antibacterial agents we now have for the local treatment of chronic sinus or ear infections, but it should be emphasized again that penicillin kills only certain bacteria, indeed only certain strains of the sensitive bacteria, and has no effect on the growth of others.

Sulfonamide powders, tyrothricin, penicillin and other bactericidal drugs may be used to great advantage at the conclusion of a surgical operation to prevent wound infection and hasten healing[1]. The bacteria are then on the surface and easily accessible to the killing action of the drug, but here again we must know what organisms we are dealing with and whether they are sensitive or resistant to the drug, or combination of drugs, we are using.

In this age of chemotherapy new compounds that destroy bacteria without injuring the host will continue to be discovered. Many of these will be selective in their action. Two new antibacterial drugs (tyrothricin and penicillin) are discussed in this paper. In some respects they are superior to the sulfonamides, but they also have their disadvantages, which will be discussed later. Tables 1-4 show that streptococci are more resistant than pneumococci and that staphylococci, of all gram-positive organisms, are most resistant to the action of tyrothricin and penicillin. These studies also show that certain strains of these organisms are more sensitive than others. A strain may be sensitive to tyrothricin and resistant to penicillin, and vice versa. In other words they supplement each other to a certain extent, a fact that may be of decided practical value in the treatment of infection.

TECHNIC OF TITRATION TESTS

The methods employed for determining the sensitivity of bacteria to penicillin and tyrothricin (Tables 1-4) are described in the following paragraphs.

The infecting organism is isolated in pure culture by the usual bacteriological procedures and grown in 5 cc. of beef infusion broth for 24 hours. This culture is used to determine the susceptibility of the organism to tyrothricin and penicillin.

A 2% stock solution of tyrothricin in 94% alcohol is diluted as follows: 0.5 cc. of tyrothricin is withdrawn in a sterile 1 cc. syringe and transferred to 9.5 cc. of distilled water, the resulting tyrothricin dilution being 1:1000. This is prepared immediately before using. The stock solution of penicillin is kept frozen in the -20° C. refrigerator and is thawed immediately before using. It is diluted with equal amounts of saline.

Two series of eight tubes are set up for each organism to be tested—the first tube of each series containing 9.5 cc. and all of the remaining tubes, 5 cc. of beef

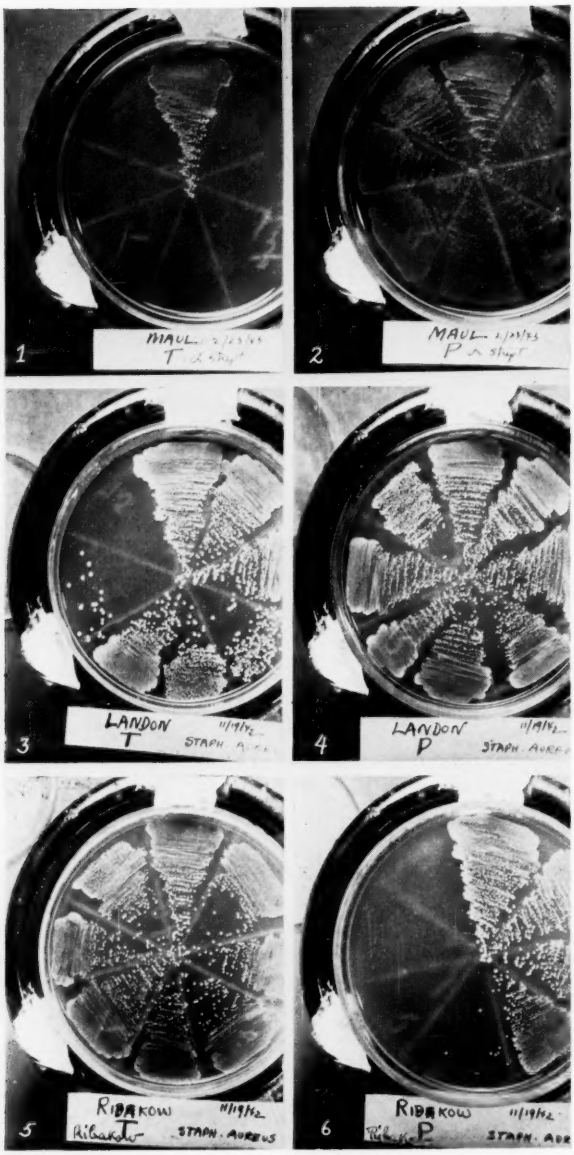
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Fig. 1

Fig. 1.—Subcultures from broth tubes containing tyrothricin or penicillin to infusion blood agar, which is entirely free of tyrothricin or penicillin. The segment at the top of each plate is the control. Reading counterclockwise, the first segment in the tyrothricin (T) plates has been inoculated with 1 loop from the 1:20,000 broth tube, the second segment from the 1:40,000 broth tube, etc. The same is true for the penicillin (P) plates, except for the dilution, which is 1:20, 1:40, etc.

Maul: (Table 3, alpha streptococci, No. 5). A strain of alpha hemolytic Streptococcus which is killed by tyrothricin, even in a dilution of 1:280,000 (photograph No. 1), but is resistant to penicillin (2). Obviously penicillin would be of no value in the treatment of an infection with this particular strain of alpha streptococcus. Photographs of plates (3) to (10) illustrate the effect of tyrothricin and penicillin on various strains of staphylococcus.

Landon: (Table 1, No. 23). All organisms have been killed in the 1:20,000 segment, but are either inhibited or not effected at all by the higher dilutions of tyrothricin (3). This strain is totally resistant to penicillin (4).

Ribakow: (Table 1, No. 52). Resistant to tyrothricin (5) and sensitive to penicillin (6).

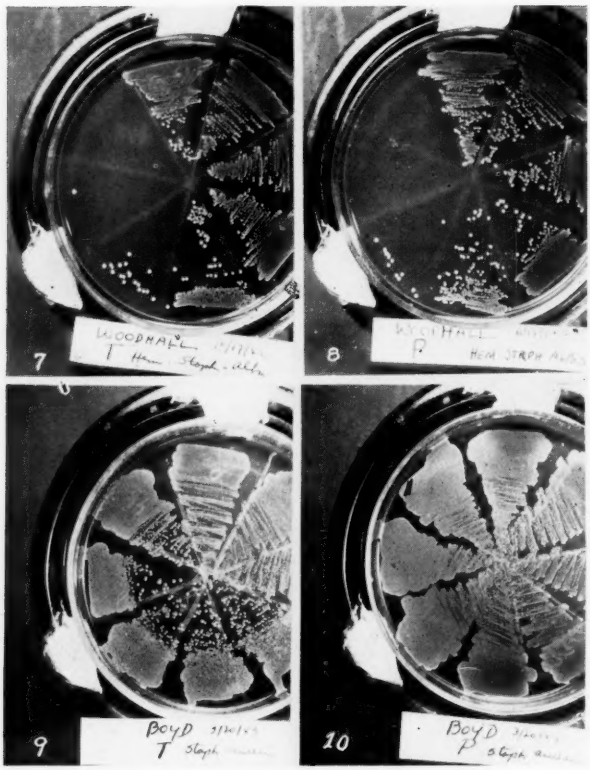

Fig. 2.—Subcultures from broth tubes as explained under Fig. 1.

Woodhall: (Table 1, No. 14). This strain, incorrectly marked hemolytic Staphylococcus albus, is moderately sensitive to both tyrothricin (7) and penicillin (8).

Boyd: (Table 1, No. 59). Sensitization tests have shown that 9 of the 59 patients in Table 1 were infected with a strain of staphylococcus resistant to tyrothricin (9), and in 12 of the 59 the organism was resistant to penicillin (10). In only 3 cases was the organism resistant to both tyrothricin and penicillin.

infusion broth pH 7.6. The first seven tubes of Series A are used for the penicillin dilutions, the first seven tubes of Series B are used for the tyrothricin dilutions and the eighth tube of each series is used as a growth control.

With a sterile 1 cc. pipette, 0.5 cc. of penicillin is transferred to the first tube of Series A, mixed thoroughly, and 5 cc. of this penicillin-broth mixture is trans-

ferred to the second tube of broth, 5 cc. transferred to the third tube and so on to the seventh tube from which 5 cc. are discarded. The dilutions of penicillin in the first seven tubes are thus: 1:20, 1:40, 1:80, 1:160, 1:320, 1:640 and 1:1280.

This procedure is duplicated for Series B by adding and mixing well 0.5 cc. of the 1:1000 dilution of tyrothricin in the first tube of broth, and transferring 5 cc. of this tyrothricin-broth mixture to the second tube and so forth. The dilutions of tyrothricin in the first seven tubes are thus 1:20,000, 1:40,000, 1:80,000, 1:160,000, 1:320,000, 1:640,000 and 1:1,280,000.

One drop of the culture, which has been grown in beef infusion broth pH 7.6 for 24 hours, is used as the inoculum in each of the eight tubes of Series A and Series B. If the organism to be tested is a beta hemolytic streptococcus or a pneumococcus, it must be grown in infusion broth enriched with rabbit blood. Therefore one drop of defibrinated rabbit blood is added to all tubes in each series. All tubes are then incubated at 37.5° C. and examined for growth after 24 hours and again after 48 hours.

Each tube, after examination, is subcultured or transferred to a fresh medium which is completely free of tyrothricin or penicillin. This is done to determine whether tyrothricin and penicillin kill the organism, inhibit its growth or do not affect the organism at all. Petri dishes containing infusion blood agar are ruled off with a red pencil into eight pie-shaped segments. One loopful of culture is transferred from each of the eight tubes to each of the eight segments of the plate, section No. 1 corresponding to tube No. 1 (1:20 dilution), section No. 2 corresponding to tube No. 2 (1:40 dilution) etc. Thus two blood agar plates are used for each organism tested, one for the eight tubes in Series A (penicillin dilutions and control) and one for Series B (tyrothricin dilutions and control). These plates are incubated and examined at the end of 24 hours. Results of the growth or absence of growth on the plates are recorded for each dilution, "—" indicating complete killing of the organism, "I" indicating inhibition and "N" indicating normal growth similar to the control (Tables 1-4).

We found in reading the plates that there were many degrees of inhibition, the interpretation of which was so subjective, that photographs of the plates were made. (Figs. 1 and 2).

Penicillin is an antibacterial substance produced by the growth of certain strains of Penicillium notatum on suitable liquid culture media. The original observations were made by Fleming in England in 1929[2], and further studies were carried out by Clutterbuck, et al in 1932[3]. These authors found that the mould could be grown on a synthetic medium and the active principle extracted by ether at a low pH. Since 1940 there has been an increasing interest in the chemotherapeutic application of penicillin, and many reports have appeared from England and from this country[4-8]. From this work it has been established that penicillin is active mainly against gram-positive cocci but also against gonococci, meningococci, Clostridium welchii, anaerobic streptococci, and others. The purified

extract is active in very high dilutions and is not inhibited by pus, exudates, tissue cells or para-aminobenzoic acid, and is nontoxic even in large doses. Its extraction, however, is complicated and requires a great deal of crude material and consequently the supply is still too limited for general distribution. We have not attempted to prepare any of the purified penicillin, but have employed the whole culture filtrate for our studies of its antibacterial properties and for the clinical trials reported in this paper.

The methods of preparation, preservation, and toxicity experiments, are given in more detail in another paper[9], but the following outlines the essential details in brief. The penicillium used for most of the cultures is one of the original "Fleming" strains. The media that has been found most suitable is 3% amino acid mixture (Casamino Acids or Casamino Acids Technical) and 2% brown sugar in distilled water. This is adjusted to pH 4.5 and placed in flat flasks in shallow layers and autoclaved. These flasks are inoculated from the stock culture which is kept on solid media, and the cultivation is carried out at room temperature (approximately 22° to 25° C.). Tests for activity are made from time to time as well as tests for changes in pH. The antibacterial titer is usually at its height in five to seven days, when a pH of 7 or 8 has been reached. It is then brought to a pH of 6.5 or 7 and filtered through a Seitz filter—some inactive penicillin being passed through the filter first, as this seems to prevent absorption of much of the active substance which would otherwise be lost. This filtrate, the "crude penicillin", is put immediately into sterile flasks and frozen. It can be kept active in this way from two to five months, being thawed when needed and then refrozen. It will remain potent in the ordinary icebox for about a week, but gradually loses activity after that unless kept in rubber-stoppered bottles. When kept in rubber-stoppered bottles it retains much, but not all, of its activity for a month or more, but it is preferable to keep crude penicillin frozen. When frozen and then thawed a dark, yellowish-brown liquid settles to the bottom of the flask, which has been found to be more potent than the lighter colored fluid in the upper part of the flask. This more concentrated penicillin is pipetted off as needed for in vitro tests and clinical application. It may be diluted with equal parts of saline or used full strength.

This crude penicillin has been tested for toxicity by intravenous and intraperitoneal injection in mice, guinea pigs and rabbits, in large and repeated doses; no signs of toxicity have been observed. It has also been given intracutaneously and subcutaneously in mice and rabbits, intrabronchially in rats and into the conjunctival sac of

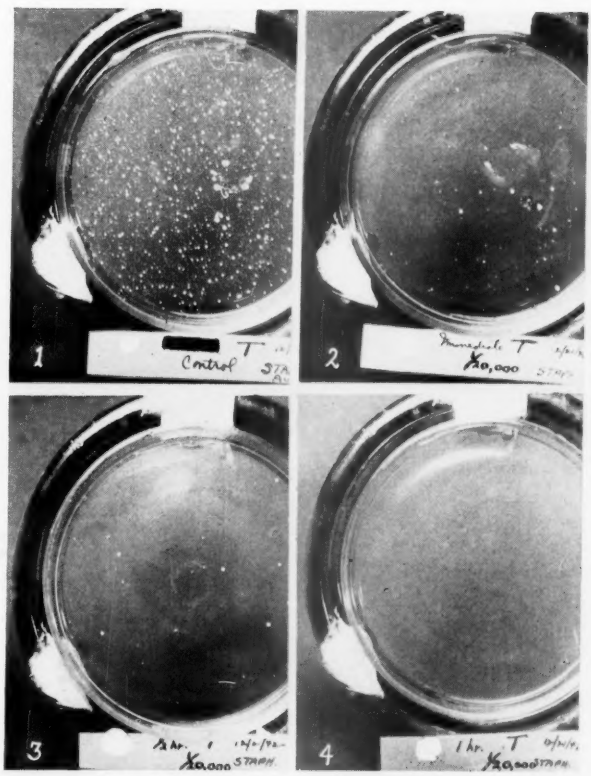

Fig. 3.—It was emphasized in the text that tyrothricin was most valuable when used at operation to prevent wound infection, since its bactericidal action is more rapid than that of penicillin. Photographs 1-4 show the rapidity with which tyrothricin kills staphylococcus, when contrasted with the slower action of penicillin (Fig. 4). The plate poured immediately, (*i. e.* within 2 or 3 minutes after inoculating with one drop of a 24-hour staphylococcus culture a 5 cc. broth tube containing tyrothricin in the proportion of 1:20,000) shows a marked reduction in the number of organisms (2). The plate poured at the end of an hour is sterile (4).

rabbits before and after its intravenous administration in these animals; these results were also negative. We may conclude, therefore, that penicillin is nontoxic to animals both by local and parenteral administration.

The mechanism of action of penicillin is not definitely known, but we have shown that it is bactericidal in the lower dilutions and bacteriostatic in higher ones. It acts much more slowly than tyrothricin, but shows definite killing power in two hours and bacteriostasis during the two hours before the killing effect becomes marked. This is demonstrated in the curves and photographs (Figs. 3-5).

Tyrothricin[10, 11] is a bactericidal substance that was isolated by René Dubos in 1939, from peptone cultures of the aerobic soil bacterium, Bacillus brevis. A number of substances have been discovered by Dubos and his associates, all of which have antibacterial activity. From one of these, tyrothricin, two crystalline components, gramicidin and tyrocidine, have been separated. Gramicidin is bactericidal for gram-positive organisms only; tyrocidine contributes to the solubility and stability of the active principle gramicidin. For the clinical trials and sensitivity tests in this report the mother substance tyrothricin has been used. The bactericidal activity of tyrothricin is inhibited by phospholipids, which may explain its relative inactivity in the intestinal tract. Tyrothricin is very stable in alkaline media or in alcoholic solution, but its in vitro activity is rapidly lost at reactions more acid than pH 5.5.

Tyrothricin has a strong hemolytic action that prohibits its use intravenously and subcutaneously, but under certain conditions it is a valuable agent for the treatment of infection. A most important condition for successful treatment is that the tyrothricin come into direct contact with the infecting bacteria. It kills gram-positive aerobic and anaerobic bacteria with great rapidity, and is not destructive to tissues. Dubos and others have shown that 2 mg. of tyrothricin injected into the peritoneal cavity of mice will protect a majority of the animals from many thousand times the fatal dose of pneumococci, provided the two injections are made simultaneously. As the interval between the injection of tyrothricin and bacteria lengthens, the mortality rate of the mice rapidly increases. In the body, as in the test tube, tyrothricin must come into direct contact with the bacteria in order to kill them. The demonstration that tyrothricin will kill a certain type or strain of bacteria in the test tube is no guarantee that it will cure an infection with this organism in a human being. Clinical results depend on the accessibility of the

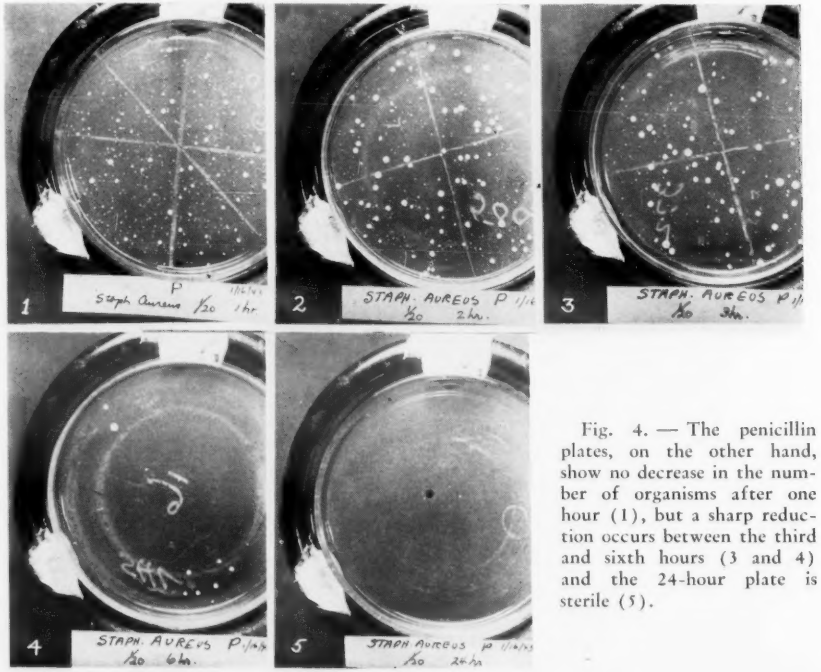

Fig. 4. — The penicillin plates, on the other hand, show no decrease in the number of organisms after one hour (1), but a sharp reduction occurs between the third and sixth hours (3 and 4) and the 24-hour plate is sterile (5).

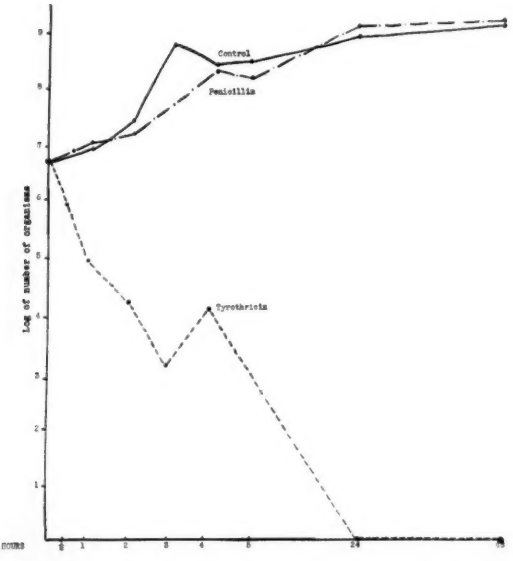

Fig. 5.—Effect of tyrothricin and penicillin on staphylococcus moderately sensitive to tyrothricin and resistant to penicillin (Boyd). Note the rapid bactericidal action of tyrothricin (1:20,000) for the first 3 hours, with complete killing occurring between the 4th and 24th hours. The plates were incubated for an additional 24 hours and were still sterile. The growth in 1:20 penicillin was about the same as the control.

organism to the action of the drug. For this reason tyrothricin is more effective when used to supplement surgical operations, such as for chronic sinusitis or mastoiditis.

Bacteria brought to the surface by removal of infected tissue are killed almost instantaneously, and wound infection and its consequences may be prevented by using throughout the operation a 1:5000 suspension of tyrothricin in distilled water in place of the usual saline for wound irrigation.

Tyrothricin must be applied locally since it is toxic when injected into the veins or tissues. It is soluble in alcohol but insoluble in water. It remains stable for an indefinite period in alcoholic solution, but its potency is gradually lost by contact with water, either in a test tube or in the tissues. The stock solution (2% in 94% alcohol) is kept in 10 cc. bottles covered with a rubber cap, such as the allergists

use for hay fever extracts and vaccines. By withdrawing the required amount of the alcoholic solution with a syringe and mixing it with distilled water, a fresh suspension of tyrothricin may be quickly prepared for use at operation or treatment. Distilled or double distilled water is essential, because the least trace of salt or mineral precipitates the tyrothricin into clumps that prevent its even distribution in the wound. A 1:10,000 or 1:20,000 suspension is used for postoperative treatments. More concentrated suspensions may be used at operation, but in the absence of anesthesia they may cause burning, sneezing and other evidence of mucous membrane irritation.

The tyrothricin suspension must come into actual contact with the bacteria; therefore, repeated irrigations of a chronically infected sinus rarely effects a lasting cure. The number of bacteria may be greatly reduced, indeed several cultures during the course of treatment may be sterile, but this result is not permanent. The contrary is true for acute sinus infections. The difference in results of treatment of acute and chronic infections suggests that in the former the bacteria are nearer the surface, but have penetrated deeper into the tissues in the more chronic conditions.

Tyrothricin is most valuable when used to supplement surgical operation. In suitable cases it prevents wound infection by killing all susceptible bacteria brought to the surface by the operative procedure just as effectively as it kills them in a test tube. Tyrothricin acts specifically on the bacteria and does not injure tissues or retard healing. The absence of wound infection attained in this way greatly reduces pain, swelling, suppuration and the frequency of postoperative treatments. Most important of all, prevention of wound infection reduces postoperative polyps and granulation-tissue formation and thus makes it possible to cure, without a deforming operation, selected cases with a chronic frontal sinus infection.

After the usual preliminary intranasal operation the frontal sinus may be entered through an external incision in the eyebrow not more than 2 or 3 cm. in length. All infected mucous membrane together with the entire floor of the frontal sinus and all orbital extensions of the ethmoidal cells are removed and a large opening made into the nose. The wound and surrounding soft parts are then thoroughly washed with 1:5,000 tyrothricin, and the frontal sinus packed with gauze saturated with tyrothricin. The external incision is closed and the end of the pack brought out through the nose. There is rarely any edema of the eyelid and the incision heals per primam.

The pack is removed under light vinethene anesthesia 24 hours later. The frontal sinus is rendered so nearly sterile by this procedure that excessive growth of granulations is prevented and therefore the opening into the nose does not close, provided the operation has been thorough and the sinus is irrigated daily for ten days with a 1:10,000, or if titration tests have shown that the organism is very sensitive, with a 1:20,000 suspension of tyrothricin.

After the first ten days, even though no gross pus has been seen in the irrigating fluid at any time since operation, the frontal sinus irrigations should continue at longer intervals for another two weeks. The object of these prolonged irrigations is to prevent the multiplication of any bacteria that may have escaped until healing is well advanced. Wound infection causes an excessive growth of granulations, which in turn interferes with drainage and forms pockets in which secretions are retained. If this should happen the operation may not be successful.

It should be emphasized again that neither tyrothricin or penicillin injures tissue, but they do kill susceptible bacteria, or so weaken them that they are easily destroyed by leucocytes. Also we should not use either of these germicides blindly, but establish by sensitization tests which drug is more effective.

All that has been said about the use of tyrothricin in the treatment of infection is with one exception equally applicable to penicillin. This exception is the time factor. As shown in Figs. 3 and 4, bacteria are killed almost instantly when brought into contact with tyrothricin, and more slowly by penicillin. For this reason we think tyrothricin is preferable in an operation where it is important to reduce wound infection and its consequences to a minimum. If the infecting organism is sensitive to both tyrothricin and penicillin, the best results are obtained by using tyrothricin at the operation and penicillin, diluted with an equal amount of normal saline, for the postoperative irrigations, since penicillin penetrates the tissues and reaches bacteria that would not be killed with tyrothricin.

Tables 1-4 show the results of sensitivity tests for staphylococcus aureus, staphylococcus albus and the various types of streptococci and pneumococci isolated from upper air passage infections of 118 patients. Opposite each name is listed the location of the infection and the sensitivity of the organism to the various dilutions of tyrothricin and penicillin used.

The strains of bacteria that are killed in the greatest number of dilutions are in the upper half of each table, those more resistant in the lower half. Table 1 shows that the penicillin, described above and made in the hospital laboratories, is just as effective as tyrothricin for killing staphylococcus aureus in the test tube, but that neither tyrothricin nor penicillin is fully satisfactory for combatting infections with this group of organisms. Some new substance must be found that will be as effective for the staphylococcus as penicillin and tyrothricin are for the pneumococcus and most streptococci. It should be noted that in the sensitivity tests the dilutions for tyrothricin and penicillin are different. Tyrothricin dilutions are on a milligram percentage basis, which vary from 1:20,000 to 1:1,280,000, while the potency of the various penicillin dilutions may be approximately calculated in terms of Oxford units.* (One cc. of penicillin has the approximate potency of 40 Oxford units).

Most important from the clinical point of view is the correlation of sensitivity tests with the results of treatment. Abstracts of clinical histories are presented in Tables 5-8 illustrating the successes and the failures in obtaining a satisfactory cure. The results are sharply contrasted in Tables 5 and 6. It is difficult to prove that the failure to cure the five patients in Table 6 was due solely to the resistance of the infecting organisms to tyrothricin and penicillin (Table 1).

In these patients the operation was done with the greatest care and the sulfonamides were used when indicated. It is our impression, however, from past experiences with operation and other types of therapy, that the result obtained in the group in Table 5 would not have been so satisfactory if we had omitted the bacteriological and sensitization tests, and had failed to use at operation and in subsequent treatments the agent that most effectively killed those particular strains of bacteria. Some of these patients were so sick that we employed every type of therapy that might aid in recovery.

For this reason it is difficult always to evaluate the part played by tyrothricin and penicillin in the cures and failures. Also it should be emphasized that this paper deals entirely with the local application of tyrothricin and unrefined pyrogen-containing penicillin to operative wounds and chronic mucous membrane infections. Tyrothricin

*An Oxford unit is the amount of penicillin that will just inhibit the growth of a standard inoculum of staphylococcus in 50 cc. of broth. This must be a very variable measure of potency, since many strains of staphylococcus are resistant to penicillin, and the strains that are sensitive vary greatly in their degree of sensitivity.

cannot be used in any other way, but penicillin when properly prepared promises to supplant the sulfonamides for intravenous treatment of septicemia and meningitis, because it is not toxic. A number of germicides are available that kill bacteria, but there are objections to their use.

The sulfonamide powders sometimes form a crust that interferes with drainage. In addition a certain number of patients become sensitized to the sulfonamides on repeated application in powdered form. They are even more likely to become sensitive when these powders are used in fresh operative wounds. Although the number of patients that become sensitized in this way is small, the consequences to the individual are serious if he later develops pneumonia, septicemia or meningitis and the administration of a sulfonamide by mouth or intravenously is followed by fever, skin rash and other toxic symptoms that prohibit the use of this drug.

It is important to prevent wound infection by the local application of some antibacterial substance that will not form crusts and interfere with drainage, will not damage tissues or interfere with healing and is not toxic. Our experience indicates that tyrothricin and penicillin are ideal for this purpose. Both are most effective for gram-positive organisms, but certain strains are sensitive to tyrothricin and not to penicillin and vice versa. Some strains of staphylococci are resistant to both tyrothricin and penicillin.

Tyrothricin used as drops or irrigations for chronic infections of the sinuses or ears is of little value. Often penicillin is more effective in these cases because it is more soluble and therefore penetrates the tissues more than tyrothricin. In one patient (Table 1, No. 18), who had had a chronic staphylococcus aureus infection of both frontal sinuses for many years, a series of bacteriological and clinical observations were made on the effect of irrigation with normal saline, sulfonamides in solution and in suspension, tyrothricin and penicillin. Saline irrigations daily for several months made the patient more comfortable, but the staphylococcus aureus persisted in pure culture. The same was true for tyrothricin, which in a 1:1000 suspension was instilled into the frontal sinuses three times a week for eleven months, in spite of the severe mucous membrane irritation that often followed the use of such a concentrated suspension.

Adequate amounts of the sulfonamides, both by mouth and as an irrigation failed to kill the staphylococcus or permanently to stop the discharge from the sinuses. After irrigating the frontal sinuses

with 5 to 10 cc. of crude penicillin three times a week for three months, the cultures became sterile, the discharge, headache and other symptoms disappeared and the patient has remained well throughout the winter of 1943. Although the tests (Table 1, No. 18), show that the staphylococcus in this case was more sensitive to tyrothricin, the clinical cure and disappearance of the organism from cultures followed local treatment with penicillin. A probable explanation is the failure of tyrothricin to reach the bacteria embedded in the thickened mucous membrane, since tyrothricin is not soluble in water and is therefore not absorbed. Penicillin on the other hand, although less potent for the particular strain of staphylococcus in this patient's frontal sinuses, is soluble in water and does penetrate tissues. At any rate there is no doubt that prolonged irrigation with penicillin cured a long-standing staphylococcus aureus infection of the frontal sinuses in this patient.

The case histories of three patients with extensive osteomyelitis of the skull and facial bones are given in order to emphasize the value of penicillin and tyrothricin in infections due to organisms resistant to the sulfonamides.

REPORT OF CASES

CASE 1—*Case illustrating the use of tyrothricin in acute sinusitis and osteomyelitis due to anaerobic streptococci:* Age, 23 years. This man was extremely ill. Following an acute infection of all sinuses he developed osteomyelitis of the frontal and facial bones on both sides. He was confined to the hospital for several weeks. Repeated cultures showed the infecting organism was an anaerobic streptococcus. Before coming to the hospital his treatment had included all of the local and general conservative measures, such as sulfathiazole and later sulfadiazine by mouth in adequate dosage, frequent irrigation of the antra and frontal sinuses with one per cent sodium sulfathiazole, rest in bed, local application of heat, and x-ray treatments over the sinuses, with no improvement. He steadily grew worse, chills were frequent and his temperature septic. His treatment while in the hospital consisted of a series of surgical operations supplemented with tyrothricin (1:1000) locally at the time of the operation and twice daily as an irrigation (1:10,000) from October 2, 1941, to December 24, 1941. Anaerobic streptococci persisted in the infected area for a month in spite of the frequent operations and irrigations. After this organism had disappeared from the cultures suppuration continued and was found to be due to staphylococcus albus, Escherichia coli and alpha Streptococcus fecalis. After another month of sinus and nasal irrigations with 1:10,000 tyrothricin the Streptococcus fecalis disappeared and a few irrigations with a sulfasuccinate solution killed the colon bacilli. The staphylococcus persists in cultures but the patient is well, rarely has a cold, no headache, no nasal obstruction and very little postnasal discharge. He was last seen 18 months after his discharge from the hospital, has very little scarring or deformity and is working regularly.

CASE 2—*Case illustrating the use of tyrothricin in acute sinusitis and extensive osteomyelitis due to the Lancefield B group of beta hemolytic streptococcus.* Age, 23 years. Following the birth of her first child symptoms of diabetes appeared, which were not recognized until she suddenly went into coma. While in a hospital for treatment of the diabetes an acute antrum and ethmoid infection on the left developed, which was followed by osteomyelitis that ultimately destroyed all of the hard palate and superior maxilla on the left, and the inferior and medial bony walls of the left orbit. The treatment consisted of thorough removal of all infected bone and all polyps and granulation tissue in the left antrum, the ethmoid and sphenoid regions at one operation, and the use of large amounts of tyrothricin 1:1000 to irrigate the wound and surrounding soft parts at operation. Since the entire left half of the hard palate and all upper teeth on this side were removed, it was easy to pack the wound with a large piece of gauze saturated with 1:5000 tyrothricin suspension. The packing was changed twice a day for three weeks. All suppuration and odor disappeared soon after the operation, and healing progressed rapidly. The defect in the roof of her mouth was repaired with a dental plate.

Before operation the odor was so bad that it was almost impossible to stay in the same room with her. At no time after the operation was there any odor, and no gross pus was seen on the dressings. The highest postoperative temperature was 100.2° F. which returned to the normal level after the fourth day. Such an extensive operation on a diabetic would never have been undertaken unless we had felt sure that postoperative wound infection and the spread of infection could be prevented with tyrothricin and insulin.

CASE 3—*Case illustrating the use of penicillin in acute sinusitis, orbital abscess and osteomyelitis of the frontal bone due to micro-aerophilic beta streptococci.* Age, 11 years. This child was admitted to the hospital on February 2, 1943, in a semiconscious condition with acute infection of the ethmoid and frontal sinuses on the left, osteomyelitis of the frontal bone on the left, marked protrusion of the left eye and swelling of surrounding soft parts, temperature 104° F., pulse 130 and white blood count 16,000. No meningeal infection or septicemia was demonstrated. She was given 3 grams of sulfathiazole by mouth immediately and 6 grams daily for a week. The micro-aerophilic beta streptococcus is a sulfonamide resistant organism, but the drug was given as a preventive measure against other organisms that might cause trouble after the operation. At operation all infected bone and mucous membrane was removed through an incision in the left eyebrow. Full strength penicillin was used to irrigate the wound and saturate the packs.

The temperature reached normal on the fourth day and the patient left the hospital on the twentieth day after operation. When last seen three months later she was well, and had no external deformity. In this patient also, an extensive surgical operation would never have been undertaken during the acute stage of sinusitis and osteomyelitis unless we had known that the infecting organism, although resistant to the sulfonamides, was extremely sensitive to both penicillin and tyrothricin.

CASE 4—*Case illustrating the use of penicillin to irrigate antra and treat ethmoids by the Proetz displacement method, in a child with chronic bilateral sinusitis for four years.* Age, 11 years. This child was brought to the out-patient department for impaired hearing. The most evident cause was the complete nasal

obstruction and the purulent discharge in his nose and nasopharynx. Repeated cultures showed Haemophilus influenzae, pneumococci and Staphylococcus aureus. For several months both maxillary sinuses were irrigated three times a week with penicillin and his ethmoids treated with penicillin by the Proetz technic.

After five months of intensive treatment the purulent nasal discharge cleared up, the congestion of the mucous membrane of the middle and inferior turbinates receded and his hearing returned to an approximately normal level. He has remained well during the winter of 1942-43.

The good result in this case was due to the absence of polyps, the frequent antral irrigations with penicillin and the Proetz method of getting this drug into the infected ethmoid and sphenoid sinuses. The length of time required to cure the infection by this method makes its general application impracticable.

CASE 5—*Case illustrating the cure of chronic bilateral sinusitis in a child treated with radon for hypertrophied adenoids and penicillin, by the Proetz method, for the ethmoidal infection. The maxillary sinuses were not irrigated.* Age, 13 years. This child was brought to the out-patient department for chronic nasal obstruction and purulent discharge continuously for two years. There was no history of headache or ear infection. No polyps were seen in either side of his nose. Both antra were dark on transillumination. Culture from the nose showed pneumococci and Haemophilus influenzae. This child's maxillary sinuses were not irrigated. His ethmoidal region was treated with penicillin, by the Proetz displacement method, three times a week for two months. The discharge gradually decreased in amount and finally became mucoid. The congested mucous membrane on the turbinates slowly returned to normal. These treatments were during August, September and part of October, 1942. He went through the winter of 1942-43 with no nasal obstruction, chronic nasal discharge or evidence of a recurrence of sinus infection.

We ascribe his freedom from colds during the past winter and absence of recurrence of sinusitis to a series of radon treatments for diffusely hypertrophied lymphoid tissue in the nasopharynx.

SUMMARY

Tyrothricin and penicillin are two new microbiotic agents, which are still in the stage of experimental clinical trials, but promise to become valuable additions to the group of drugs now in use for the prevention or cure of infection in burns, lacerated wounds and other local conditions. For two years we have used tyrothricin and unrefined pyrogen-containing penicillin locally in the treatment of acute otitis media, acute and chronic mastoiditis and acute and chronic sinusitis, with better results in many cases than we have ever had before. Both tyrothricin and pyrogen-containing penicillin are suitable for local application only, but they are not toxic, do not damage tissues or interfere with wound healing, and either inhibit the growths or entirely kill, most strains of staphylococci, streptococci and pneumococci we have encountered (Tables 1-4). Clinical results with the

use of tyrothricin in acute and chronic mucous membrane infections lead us to conclude that bacteria are growing on or near the surface in acute infections, while they are deeply embedded and inaccessible to any locally applied bactericidal agent in chronic infections (Tables 5-8).

Tyrothricin is not soluble in water and does not penetrate. This is an advantage because this drug is toxic if it reaches the blood stream. That it does not reach the blood stream when applied locally is shown by the absence of any toxic symptoms in the many cases in which we have used tyrothricin, at operation and in postoperative treatments to prevent wound infection. Prevention of wound infection is of the greatest advantage. Much postoperative discomfort is spared the patient and much time and energy saved for the surgeon. The reason for the widespread use of sulfonamide powders at operation and on postoperative dressings is the prevention of wound infection. Many of the bacteria in chronic mastoid and sinus infections, however, are resistant to the sulfonamides. In addition these powders are poorly soluble and act as foreign bodies. The chief objection to their use is that some individuals become so sensitized by local application in fresh operative wounds that the use of these invaluable drugs is precluded if the patient should develop pneumonia, meningitis or a general infection, even several years later. This phase of the subject should be further investigated by those who advocate the use of these powders in all local infections.

To use the sulfonamides, tyrothricin and penicillin to the best advantage thorough bacteriological study is essential. The technic for determining the sensitivity of infecting bacteria to penicillin and tyrothricin is given in the text. With modifications the sensitivity for the various sulfonamides may also be determined. Neither tyrothricin, penicillin nor the sulfonamides have any effect on the growth of Escherichia coli, Proteus, Pseudomonas aeruginosa and Friedländer's bacillus, which are often present in chronic infections of the ears and the sinuses.

Finally, the importance of making both aerobic and anaerobic cultures is emphasized. Unless we know what organisms we must combat and the sensitivity of each of them to the antibacterial agents at our disposal, we cannot use these drugs intelligently. New and better compounds for treating staphylococcus infections will no doubt be found, but at the present time penicillin gives the best results with this organism in both local and general infections.

The tyrothricin used in this investigation was supplied by Parke, Davis & Co., Merck & Co., E. R. Squibb & Sons, Sharp & Dohme and the Lederle Laboratories.

JOHNS HOPKINS HOSPITAL.

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— = Killing
I = Inhibited growth
N = Growth similar to control

ACTION OF TYROTHRICIN AND PENICILLIN ON HEMOLYTIC STAPHYLOCOCCUS AUREUS

	Name of patient		Location of infection	TYROTHRICIN Dilution 1: thousands 20	40	80	160	320	640	1280	PENICILLIN Dilutions 1: 20	40	80	160	320	640	1280	
1.	Cunningham	(9-18-42)	Sinuses	—	—	—	—	—	I	N	—	—	—	—	—	I	N	1
2	Reynolds			—	—	I	—	—	I	N	—	I	I	I	N	N	N	2
3	Caplinger	(8-22-42)	Mastoid	—	—	—	I	I	I	I	—	I	I	I	I	N	N	3
4	Hard	(9-3 -42)	Sinuses	—	—	—	I	I	I	N	—	I	I	N	N	N	N	4
5	Speare	(9-10-42)	Sinuses	—	—	—	I	I	N	N	I	I	N	N	N	N	N	5
6	English	(9-15-42)	Mastoid	—	—	—	I	I	N	N	—	I	I	I	N	N	N	6
7	Crawford	(9-25-42)	Sinuses-asthma	—	—	—	N	N	N	N	—	—	—	I	I	I	N	7
8	Williams	(2-3-43)	Sinuses	—	—	I	I	I	I	I	—	I	I	I	I	I	N	8
9	Gresham	(9-23-42)	Sinuses-asthma	—	—	I	I	I	I	N	I	—	I	I	I	N	N	9
10	Stevenson	(10-26-42)	Sinuses-frontal	—	—	I	I	I	I	N	—	—	I	N	N	N	N	10
11	Moore	(1 -20-43)	Chronic otitis	—	—	I	I	N	N	N	—	I	I	N	N	N	N	11
12	Swann		Sinuses	—	—	I	I	N	N	N	—	I	I	N	I	N	N	12
13	Manuel	(11-13-42)	Sinuses	—	—	I	I	N	N	N	I	I	I	N	N	N	N	13
14	Woodhall	(10-14-42)	Osteomyelitis - thumb	—	—	I	I	N	N	N	—	—	I	I	N	N	N	14
15	Raskin	(1-15-43)	Sinuses	—	—	I	I	N	N	N	I	I	—	I	N	N	N	15
16	Mayhew	(1-15-43)	Sinuses-asthma	—	I	—	I	N	N	N	I	I	I	I	I	N	N	16
17	Gifford	(9-18-42)	Sinuses	—	I	I	I	I	I	I	—	I	N	N	N	N	N	17
18	du Pont	(9-25-42)	Sinuses-asthma	—	I	I	I	I	I	I	—	I	N	N	N	N	N	18
19	Margolin	(11-1-42)	Sinuses	—	I	I	I	I	I	I	—	N	N	N	N	N	N	19
20	Hope	(11-19-42)	Mastoid	—	I	I	I	I	I	N	N	N	N	N	N	N	N	20
21	Chapman	(12-16-42)	Frontal sinus	—	I	I	I	I	N	N	I	N	N	N	N	N	N	21
22	Ramsay	(3-3-43)	Acute sinusitis	—	I	I	I	I	N	N	I	I	I	I	I	I	N	22
23	Landon	(11-19-42)	Sinuses	—	I	N	I	I	N	N	N	N	N	N	N	N	N	23
24	Lindsey	(9 -7 -42)	Sinuses	—	I	I	I	N	N	N	N	N	N	N	N	N	N	24
25	Alpern	(2-23-43)	Tonsils - ear	—	I	I	I	N	N	N	I	—	I	—	I	I	I	25
26	Price	(10-5-42)	Sinuses	—	I	I	N	N	N	N	N	N	N	N	N	N	N	26
27	Gibson	(1 -7-42)	Sinuses	—	I	I	N	N	N	N	—	N	N	N	N	N	N	27
28	Fosler	(10-12-42)	Sinuses	—	I	I	N	N	N	N	—	I	I	I	I	N	N	28
29	Kochtitzky	(10-1- 42)	Sinuses	—	I	N	N	N	N	N	—	—	—	—	I	I	I	29
30	Bart	(11-9- 42)	Acute otitis media	I	I	I	I	I	N	N	N	N	N	N	N	N	N	30
31	Hopkinson	(2- 3 -43)	Sinuses	I	—	I	I	N	N	N	—	I	I	N	N	N	N	31
32	Landon	(3-20-42)	Sinuses	I	—	I	N	N	N	N	I	I	I	N	N	N	N	32
33	Cunningham	(11-19-42)	Sinuses	I	I	I	N	N	N	N	N	N	N	N	N	N	N	33
34	La Motte	(11-12-42)	Sinuses	I	N	I	I	N	N	N	—	I	I	N	N	N	N	34
35	Edwards	(11-1-42)	Mastoid	I	I	I	N	N	N	N	I	I	N	N	N	N	N	35
36	Garrett	(10-17-42)	Osteomyelitis	I	I	I	N	N	N	N	N	N	N	N	N	N	N	36
37	Boyd	(9-13-42)	Sinuses	I	I	I	N	N	N	N	N	N	N	N	N	N	N	37
38	Powell	(11-9-42)	Mastoid	I	I	N	N	N	N	N	I	—	N	N	N	N	N	38
39	Landon	(10-1-42)	Sinuses	I	I	N	N	N	N	N	N	N	N	N	N	N	N	39
40	Armiger	(9-14-42)	Frontal sinus	I	I	N	N	N	N	N	—	—	—	N	N	N	N	40
41	Fine	(2- 5-43)	Mastoid	I	I	N	N	N	N	N	I	I	I	N	N	N	N	41
42	Cole	(2-17-43)	Sinuses	I	I	N	N	N	N	N	I	I	—	I	N	N	N	42
43	Baxter	(3-20-43)	Sinuses	I	N	N	N	N	N	N	—	I	N	N	N	N	N	43
44	Cooley	(3-30-42)	Sinuses	I	N	N	N	N	N	N	—	N	N	N	N	N	N	44
45	Balliet	(3-9-43)	Sinuses-asthma	I	N	N	N	N	N	N	I	I	N	N	N	N	N	45
46	Landon	(3-9-43)	Sinuses	I	N	N	N	N	N	N	—	I	I	N	N	N	N	46
47	Raskin	(3-39-43)	Sinuses	I	N	N	N	N	N	N	I	N	N	N	N	N	N	47
48	Fine	(3-9-43)	Mastoid	I	N	N	N	N	N	N	I	I	I	N	N	N	N	48
49	Cmigan	(3-9-43)	Mastoid	I	N	N	N	N	N	N	I	I	N	N	N	N	N	49
50	Raskin	(10-2-42)	Sinuses	I	N	N	N	N	N	N	I	I	I	I	N	N	N	50
51	Hollyday	(12-14-42)	Tonsils	N	N	N	N	N	N	N	I	I	N	N	N	N	N	51
52	Ribakow	(11-19-42)	Mastoid	N	N	N	N	N	N	N	—	—	—	I	N	N	N	52
53	MacKaye	(1 - 3 - 43)	Sinuses	N	N	N	N	N	N	N	N	N	N	N	N	N	N	53
54	Klinefelter	(10-26-42)	Acute frontal sinus	N	N	N	N	N	N	N	I	N	N	N	N	N	N	54
55	Bennett	(10-22-42)	Sinuses	N	N	N	N	N	N	N	I	I	I	N	N	N	N	55
56	Cole	(3-9-43)	Sinuses	N	N	N	N	N	N	N	N	N	N	N	N	N	N	56
57	Kurtz	(3-17-43)	Bronchiectasis	N	N	N	N	N	N	N	—	—	I	N	N	N	N	57
58	Cardone	(3-29-43)	Bronchiectasis	N	N	N	N	N	N	N	I	N	N	N	N	N	N	58
59	Boyd	(3-20-43)	Sinuses	N	N	N	N	N	N	N	N	N	N	N	N	N	N	59

Table 1.—Tests for sensitivity of hemolytic Staphylococcus aureus to tyrothricin and penicillin. The technic is described in the text. The strains of staphylococcus most sensitive to tyrothricin are in the upper half of the chart; those most resistant in the lower half. Some strains resistant to tyrothricin are killed by penicillin (Nos. 57, 52, 40). Others are resistant to penicillin and sensitive to tyrothricin (Nos. 20, 23, 24, 26 and 30). More concentrated solutions might kill many more organisms, but would be too irritating to use in nasal or sinus treatments.

— = Killing
I = Inhibited growth
N = Growth similar to control

ACTION OF TYROTHRICIN AND PENICILLIN ON STAPHYLOCOCCUS ALBUS

	Name of patient		Location of infection	TYROTHRICIN Dilution 1, thousands 20	40	80	160	320	640	1280	PENICILLIN Dilutions 1, 20	40	80	160	320	640	1280	
1	Foster	(3-15-43)	Sinuses	—	—	—	I	I	I	I	—	—	—	I	I	N	N	1
2	Raskin	(10-2-42)	Sinuses	—	—	I	I	I	I	N	I	—	—	I	I	I	I	2
3	Imui	(2-3-43)	Sinuses	—	I	I	I	I	I	I	I	—	N	N	—	—	N	3
4	McVeigh	(1-3-43)	Acute otitis media	—	I	I	I	I	I	N	—	—	—	—	—	—	—	4
5	Hayes	(2-17-43)	Mastoid	—	I	I	N	N	N	N	I	I	I	I	N	N	N	5
6	Edmunds	(2-23-43)	Sinuses	—	I	N	I	N	N	N	—	I	I	I	—	—	N	6
7	Bart	(11-9-42)	Mastoid	I	I	I	N	N	N	N	I	I	N	N	N	N	N	7
8	Powell	(11-7-42)	Mastoid	I	I	I	N	N	N	N	I	I	N	N	N	N	N	8
9	Maul	(2-17-43)	Sinuses	I	I	N	N	N	N	N	—	—	—	—	—	N	N	9
10	Hayes	(10-5-42)	Mastoid	I	N	N	N	N	N	I	—	—	—	I	I	N	N	10

Table 2.—These tests indicate that penicillin is more potent than tyrothricin for the local treatment of staphylococcus albus infections.

— = Killing
I = Inhibited growth
N = Growth similar to control

ACTION OF TYROTHRICIN AND PENICILLIN ON BETA HEMOLYTIC STREPTOCOCCI

	Name of patient		Location of infection	TYROTHRICIN Dilution 1: thousands 20	40	80	160	320	640	1280	PENICILLIN Dilution 1: 20	40	80	160	320	640	1280	
1	Young	(2-3-43)	Tonsils	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	Menninger	(2-17-43)	Mastoid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3	Watson	(3-3-43)	(micro-aerophilic) Sinus - osteomyelitis	—	—	—	—	—	—	—	—	—	—	—	—	—	I	3
4	Aburn	(8-12-42)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
5	Caplinger	(9-18-42)	Mastoid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5
6	May	(8-12-42)	Tonsils	—	—	—	—	—	—	—	I	I	I	I	I	I	I	6
7	Crawford	(12-4-42)	Sinuses-asthma	—	—	—	—	—	—	—	I	—	—	—	—	—	N	7
8	di Pietro	(1-12-43)	Sinuses	—	—	—	—	—	—	—	—	I	I	I	I	I	I	8
9	Grove	(1-12-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	—	N	9
10	Stump	(1-12-43) (Lancefield B)	Tonsils	—	—	—	—	—	—	—	—	—	I	I	I	—	—	10
11	Boyd	(3-20-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	—	N	11
12	Fisher	(1-12-43)	Tonsils	—	—	—	—	—	—	I	I	I	I	I	I	I	—	12
13	Harris	(11-19-42)	Mastoid	—	—	—	—	—	—	I	—	—	—	—	—	—	N	13
14	Webster	(3-13-43)	Sinuses	—	—	—	—	—	—	N	—	—	—	—	I	I	N	14
15	Pinney	(3-29-43)	Acute otitis media	—	—	—	—	—	—	N	—	—	—	—	—	I	N	15
16	Simpson	(3-9-43)	Tonsils	—	—	—	—	—	—	N	—	—	—	—	—	—	N	16
17	Gifford	(12-4-42)	Sinuses	—	—	—	—	I	—	N	—	I	—	I	N	N	N	17
18	Griffith	(Lancefield B)		—	—	—	—	I	I	N	—	I	I	N	N	N	N	18
19	Dolowitz	(11-9-42)	Sinuses-asthma	—	—	—	—	I	I	N	I	—	—	—	I	I	N	19
20	Bennett	(10-26-42)	Sinuses	—	—	—	—	I	N	N	—	—	I	I	I	I	N	20
21	Bryant	(3-3-43)	Sinuses	—	—	—	I	I	I	N	—	—	—	—	—	—	N	21
22	Kelley-Smith	(11-1-42) (Lancefield D)	Nasopharynx	—	—	I	I	I	N	N	—	—	—	—	—	—	N	22
23	Porter	(12-4-42)	Nasopharynx	—	—	I	N	N	N	N	I	I	—	I	I	—	I	23
24	Algern	(2-23-43)	Ear	I	I	I	I	N	N	N	—	—	—	—	—	—	—	24
25	Kechtitsky	(10-1-42)	Sinuses	I	N	N	N	N	N	N	N	N	N	N	N	N	N	25
26	Chase	(10-1-42) (Lancefield B)	Tonsils	N	N	N	N	N	N	N	—	—	—	—	I	I	N	26

ACTION OF TYROTHRICIN AND PENICILLIN ON ALPHA STREPTOCOCCI

1	Fisher	(2-3-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	—	I	1
2	Flinefelter	(10-26-42)	Frontal sinus	—	—	—	—	—	—	—	—	—	—	I	I	I	I	2
3	Cole	(2-23-43)	Sinuses	—	—	—	—	—	—	—	N	N	N	N	N	N	N	3
4	Maul	(2-23-43)	Sinuses	—	—	—	—	—	—	—	N	N	N	N	N	N	N	4
5	Gifford	(10-1-42)	Sinuses	—	—	—	I	I	I	I	—	—	—	I	I	I	I	5

ACTION OF TYROTHRICIN AND PENICILLIN ON ALPHA STREPTOCOCCUS FECALIS

1	Valentine	(11-1-42)	Ear	—	I	I	N	N	N	N	N	N	N	N	N	N	N	1

ACTION OF TYROTHRICIN AND PENICILLIN ON GAMMA STREPTOCOCCUS

1	Edwards	(3-9-43)	Sinuses	—	—	—	—	—	—	N	—	—	—	N	N	N	N	1

Table 3.—The strain of Lancefield B. streptococci in No. 10 is killed with tyrothricin in all dilutions, but is resistant in No. 26. The Lancefield D in No. 22 is very sensitive to penicillin. Lancefield B and D are both resistant to the action of sulfonamides, either by mouth or locally.

— = Killing
I = Inhibited growth
N = Growth similar to control

ACTION OF TYROTHRICIN AND PENICILLIN ON PNEUMOCOCCI

	Name of patient		Location of infection	TYROTHRICIN Dilution 1: thousands 20	40	80	160	320	640	1280	PENICILLIN Dilution 1: 20	40	80	160	320	640	1280	
1	Ennis	(1-28-43)	Sinus-meningitis	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
2	Crouse	(2-17-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
3	Mitchell	(2-23-43)	Mastoid	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
4	Nevin	(10-26-42)	Tonsils	—	—	—	—	—	—	—	—	—	—	N	N	N	N	N	4
5	Klinefelter	(10-26-42)	Sinus - frontal (type 3)	—	—	—	—	—	—	—	—	—	—	—	I	N	N	N	5
6	Ramsay	(3-3-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	N	N	N	N	6
7	Winsor	(10-10-42)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	—	I	N	N	7
8	Woodhall	(9-25-42)	Sinuses	—	—	—	—	—	—	—	I	N	N	N	N	N	N	N	8
9	Bart	(11-4-42)	Sinuses - mastoid	—	—	—	—	—	—	—	—	—	—	I	I	I	I	I	9
10	Smolian	(10-8-42)	Sinuses - asthma	—	—	—	—	—	—	—	—	—	—	—	—	—	—	N	10
11	Bezark	(11-19-42)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	I	N	N	N	11
12	Green	(3-9-43)	Acute otitis media	—	—	—	—	—	—	—	—	—	—	—	—	N	N	N	12
13	Kurtz	(3-29-43)	Bronchiectasis	—	—	—	—	—	—	—	—	—	—	—	N	N	N	N	13
14	Dolby	(3-29-43)	Sinuses - ear	—	—	—	—	—	—	—	—	—	—	—	N	N	N	N	14
15	Parks	(3-15-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	I	I	N	N	15
16	Hepburn	(3-9-43)	Sinuses	—	—	—	—	—	—	—	—	—	—	—	N	I	N	N	16
17	Keene	(2-23-43)	Mastoid	—	—	—	—	—	—	I	—	—	I	N	N	N	N	N	17
18	Kavaldjian	(8-24-42)	Nasopharynx	—	—	—	—	—	—	N	—	—	—	—	—	I	I	I	18
19	Landon	(3-20-43)	Acute sinusitis	—	—	—	—	—	—	—	—	—	—	N	—	N	N	N	19
20	Armiger	(9-14-42)	Sinus - frontal	—	—	I	I	I	I	I	—	—	—	—	—	I	I	I	20

Table 4.—This table shows that pneumococci are more sensitive to tyrothricin than to penicillin. We regret that a more detailed identification of the types of penumococci, streptococci and staphylococci could not be made for lack of technical assistance due to the war.

TABLE 5—CASE HISTORIES ILLUSTRATING THE COMPARATIVELY RAPID AND COMPLETE CURE FOLLOWING OPERATION WHEN THE INFECTING ORGANISM (STAPHYLOCOCCUS AUREUS) IS SENSITIVE TO TYROTHRICIN OR PENICILLIN

Case Number Table 1 Race, Sex, Age	Site of Infection	Symptoms	TREATMENT					RESULT		COMMENTS
			Local	Operation	Tyrothricin	Penicillin	Sulfonamides	Postoperative Reaction	Postoperative Treatments	Immediate Result	Last Report	
No. 1 W M 40	Ethmoids, sphenoid, antrum, left, chronic.	Headache, nasal obstruction, discharge, left, for six months.		+	+			Temp. 101.2° F. for 24 hours after ethmoid operation—normal after that. Septic temp. to 100.2° F. for a week after radical antrum operation. No swelling of face or nasal obstruction.	Antrum and left side nose irrigated daily for 5 days after operation with tyrothricin 1-10,000 in distilled water.	No pus seen in nose or sinuses at any time after operation.	Discharged on the 12th day. No headache, nasal obstruction or discharge. Returned with a cold but no recurrence of sinus infection. No. 33, Table 1.	Heavy growth H. staph. aureus in culture from ethmoids. Heavy growth anaerobic strep. in culture from antrum. Tyrothricin 1-2000 in distilled water used on sponges and packs at nasal operation. Tyrothricin 1-1000 in distilled water used on sponges and packs at antrum operation. Packs removed after 24 hours.
No. 3 W M 8	Mastoid, left, for 2 years (acute attack).	Pain, purulent discharge. Temp. 103°F. W. B. C. 31,000.		+	+	+	+	Highest postoperative temp. 100.8°F.	Wound irrigated and packed with gauze saturated with tyrothricin 1-10,000 for 4 days—discharge continues. Changed to penicillin, full strength.	Continued discharge due to incomplete operation in attempt to save hearing—a modified radical. The microbiotic substances could not reach infected mucous membrane in middle ear and eustachian tube.	Discharged on the 16th day. Ear not dry. Well 2 months later. Hearing is good.	On admission temp. 103°F. Sulfathiazole caused rising temperature and subcutaneous nodules. Changed to sulfadiazine, temperature rapidly became normal. Modified radical mastoid operation. Wound thoroughly washed out and packs saturated with tyrothricin 1-10,000.
No. 6 W F 14	Mastoid, right for 10 years.	Chronic suppuration. Impaired hearing. vertigo.		+	+	+	+	Temp. 100°F.—normal after 12 hours.	Sulfathiazole powder did not stop discharge. Penicillin, full strength, did not stop discharge. Eustachian tube and middle ear irrigated, through catheter in the eustachian tube, with tyrothricin 1-10,000 in distilled water. Discharge stopped promptly.	Continued discharge due to infection in eustachian tube. Promptly cleared up after irrigation of eustachian tube with tyrothricin.	Discharge stopped promptly and permanently after two eustachian tube irrigations with tyrothricin. Well 8 months later.	The continued discharge after radical mastoid operation was due to infection in eustachian tube which was not reached by sulfa powder blown into wound or penicillin irrigations of wound, but promptly stopped after two irrigations through catheter in eustachian tube.
No. 7 W F 43	Ethmoid, sphenoid, antra, right and left. Asthma.	Coughing, severe asthma and chronic postnasal discharge for 5 years.		+		+	+	Following bilateral radical antrum temp. remained between 99° and 101°F. for 3 weeks.	Sulfadiazine by mouth for a week. No local treatment for 10 days due to asthma, then daily irrigations of nose and sinuses with penicillin full strength.	Severe attacks asthma for 10 days following operations. Some cellulitis both sides face after antrum operation.	Well 8 months later. No recurrence of polyps. No crusts in the nose. No coughing or asthma. Leads a normal life.	This patient had had extremely severe asthmatic bronchitis for 5 years. For several weeks previous to operation on sinuses was in oxygen tent most of time.

No. 8 C M 21	Ethmoid, sphenoid, antrum, left for 3 months.	Severe headache, left. Nasal obstruction and purulent discharge.	+ + +	Following radical antrum (left) temp, 101.6°F.—normal 12 hours later.	Tyrothricin 1-3000 in distilled water used to wash out wound and soak packs at operation. Two postoperative irrigations with tyrothricin 1-10,000 in distilled water.	No swelling of face or discharge from sinuses. Nose and sinuses irrigated only twice after operation.	Well when last seen, 3 weeks after operation.	Heavy growth anaerobic strep. in left antrum. Staph. aureus in ethmoids. Frequent antrum irrigations, previous to operation, with tyrothricin 1-5000 and penicillin full strength failed to cure the infection.
No. 9 W F 46	Pansinusitis bilateral, nasal polyps. Severe asthma.	Asthmatic bronchitis. Nasal obstruction, discharge for 5 years.	+ + +	No swelling of eyelids or face. No pus seen at any time after operation. Temp. 100°F. for 24 hours, then normal.	After packs were removed on 3rd day, the frontals were irrigated daily for 10 days with tyrothricin 1-20,000 or penicillin 1-20.	Asthma and cough much less. No headache or postnasal discharge.	The opening from nose into frontals remained patent. No polyps or granulations.	Each frontal sinus opened through small external incision, polyps and all mucous membrane removed, then thoroughly washed with tyrothricin 1-1000 in distilled water. Packed with gauze saturated with penicillin full strength, removed on 3rd day. External incisions closed. The infection was completely cured without deformity of any kind.
No. 10 W M 56	Acute exacerbation of chronic sinusitis left frontal.	Headache, edema eyelids, left, protrusion left eye for 2 weeks.	+ + +	Temp. 102.5°F. day of operation. Normal on 2nd day. No postoperative pain. No increased swelling of eye.	Packs removed 48 hours. Frontals irrigated daily for 7 days with tyrothricin 1-10,000, then once a week for a month. No pus washed out at any time.	Pain ceased, swelling rapidly disappeared. No purulent discharge in nose at any time after operation.	No polyps or granulations, no discharge. Opening from nose into frontal remains patent after 6 months. Discharged well on 9th day after operation.	At operation an abscess in left orbit was found. Granulations removed. Wound thoroughly washed out with tyrothricin 1-4000 in distilled water. Wound packed with gauze saturated with tyrothricin 1-4000, removed after 48 hours. Sulfadiazine (mouth) for 5 days. External incision healed per primam.
No. 14 W F 33	Osteomyelitis, thumb following injury 8 months ago.	Pain, swelling purulent discharge for 8 months.	+ +	The thumb was so swollen and painful that amputation had been advised. After removal sequestrum the wound was irrigated daily with tyrothricin 1-1000 in distilled water. No granulations formed, no purulent discharge. No reaction of any kind from the tyrothricin.			Entirely healed in a week. Has remained well 6 months.	Under local anesthesia a small sequestrum removed. This was 3rd operation of this kind. Previously wound had continued to suppurate and filled with granulations.
No. 17 W M 58	Frontal, ethmoid and antrum infection for several years.	Repeated acute respiratory infections. Chronic purulent nasal discharge.	+ + +	Following intranasal operation on ethmoid (penicillin used) there was no swelling or pain. Temp. 99°-100°F. for 24 hours, then normal. Following external frontal sinus operation (tyrothricin used) temp. 100.2°F. but normal after 12 hours. No swelling of eyelids or pain.	Ethmoids and left frontal irrigated daily for a week with tyrothricin 1-10,000.	No pain, swelling of face, or purulent discharge seen in nose at any time after operation.	Discharged on 23rd day. Seven months after operation writes that he has had a good winter with none of his old symptoms. Well.	Intranasal opening ethmoid cells, left. Penicillin full strength in wound and on packs. Frontal sinus operation through small external incision. No deformity. Tyrothricin used.
No. 21 W M 15	Frontal, right for 3 years. (Has had two external frontal operations).	Chronic osteomyelitis. A draining sinus tract in upper lid, right, leading into frontal. Exophthalmus right.	+ +	Had irregular elevation of temperature (highest 100.5°F. for 4 days after operation. No pain or increased swelling.	Right frontal irrigated daily with tyrothricin 1-10,000 in distilled water (through a catheter passed through nose into frontal), then once a week for 2 weeks.	No purulent discharge on dressing or in irrigating fluid at any time after operation.	Discharged on 10th day. Letter 4 months later reports he is well.	External incision over right frontal, granulations, polyps and infected bone removed. No attempt to do a radical deforming operation. Culture: hemolytic staph. aureus. Wound thoroughly washed with tyrothricin 1-5000 in distilled water. Packs saturated with this tyrothricin suspension left in frontal for 48 hours.

TABLE 6—CASE HISTORIES ILLUSTRATING THE FAILURE TO CURE FOLLOWING OPERATION WHEN THE INFECTING ORGANISM (STAPHYLOCOCCUS AUREUS) IS NOT SENSITIVE OR LOSES ITS SENSITIVITY TO TYROTHRICIN OR PENICILLIN

Case Number Table 1 Race, Sex, Age	Site of Infection	Symptoms	TREATMENT				RESULT			COMMENTS
			Local	Operation	Tyrothricin	Penicillin	Sulfonamides	Postoperative Reaction	Postoperative Treatments	Immediate Result	Last Report	
No. 15 W M 16 (See Nos. 50 and 47 Table 1 for loss of sensitivity to Tyrothricin).	Frontal, ethmoid, sphenoid and antrum, left, for 4 years.	Headache, nasal obstruction and purulent discharge, left.		+	+		+	Temp. remained normal. No pain or swelling, but discharge continued and granulations formed around naso-frontal opening. Is allergic to our penicillin solution so could not use it.	Frontal and other sinuses on left irrigated daily for two months with tyrothricin 1-10,000 in distilled water. Culture still showed hemolytic staph. aureus, the alpha strep. fecalis had disappeared. Had adequate course sulfadiazine by mouth with no benefit.	No swelling or redness of eyelids. Incision healed per primam, but discharge from sinuses continued in spite of frequent irrigations with tyrothricin 1-10,000.	Discharged on the 4th day after operation, but has been irrigated with tyrothricin 3 to 7 times a week for nearly 8 months. Still has hemolytic staph. aureus and discharge from left frontal.	8-18-42: Left frontal opened through small external incision (exactly like No. 17, Table 1). Granulations and polyps removed, wound thoroughly washed with and packs saturated with tyrothricin 1-5000 in distilled water. Removed after 48 hours. Culture: hemolytic staph. aureus, alpha strep. fecalis. Also intranasal operation on ethmoid and sphenoid. Had previously had radical left antrum operation. A radical frontal sinus operation will probably be necessary to cure this patient.
No. 37 W M 53 (See No. 59 Table 1, for loss of sensitivity to Tyrothricin).	Frontal, ethmoid, sphenoid antrum, left, for 25 years.	Headache, nasal obstruction and purulent discharge, left.		+	+		+	Temp. remained normal. No pain or swelling but discharge from frontal continues. (16 months later).	Frontal and other sinuses on left irrigated daily for a month with tyrothricin, then frequently for a year with saline. Recently frontal has been irrigated with sulfathiazole in paredrine with some improvement.	Headache and nasal obstruction relieved but discharge continues.	Discharged on the 30th day after operation. 16 months later general health improved, but discharge from frontal continues.	1-15-42: Left frontal opened through small external incision. Granulations and polyps removed. Culture: hemolytic staph. aureus. Wound washed with and packs saturated with tyrothricin 1-5000 in distilled water. Removed two days later. His organism is entirely insensitive to our penicillin (see Nos. 37 and 59, Table 1).
No. 55 W F 31	Ethmoid, right, and nasal polyps.	Nasal obstruction and discharge. Arthritis.		+	+	+	+	After intranasal operation no rise of temp. but cellulitis right orbit. Given sulfadiazine by mouth.	Daily treatments with tyrothricin for 14 days failed to stop the nasal discharge.	Arthritis improved and patient felt better, but nasal discharge continues.	Discharged on the 14th day. Still having purulent discharge from sinuses. Returned 6 months later, nasal discharge continues.	Given sulfadiazine (mouth) for a week following ethmoid operation. April 1942: Intranasal operation on infected ethmoids. Tyrothricin 1-5000 in distilled water used on packs and daily irrigations for 2 weeks. Discharge continues. October 1942: Returned. Still thick purulent nasal discharge. Penicillin used in daily treatments for nearly 3 weeks. No improvement.

No. 56 W M 34	Frontal, ethmoid, antrum, right, for several years.	Headache, nasal obstruction, right. Purulent nasal discharge.	+	+	After intranasal ethmoid operation no rise of temp. After radical antrum operation right, highest temp. 99.5°F.	Daily irrigation nose and sinuses on right with saline followed by penicillin full strength.	Continues to have some headache and nasal discharge.	Discharged on the 17th day. Still having purulent discharge from sinuses.	3-9-43: Intranasal ethmoid operation. Wound washed with and packs saturated with penicillin full strength. Removed after 12 hours. Following radical antrum operation two days later the nose and sinuses were irrigated with penicillin daily for 17 days. Still had a purulent discharge.
No. 48 W M 32 (See No. 41 Table 1, for loss of sensitivity to tyrothricin).	Mastoid (attic) left for 8 months.	Pain, impaired hearing and discharge in left ear.	+	+ +	After modified radical mastoid operation, highest temp. 99,8°F. Normal after 12 hours. No swelling or redness around incision.	Cleaned out discharge with dry cotton and filled wound with tyrothricin 1-10,000 in distilled water 4 to 5 times a week for 10 weeks.	No headache. Discharge continues.	Left hospital on 6th day. Treatments with tyrothricin 4 to 5 times a week, for 10 weeks. Still has discharge and hemolytic staph. aureus in pure culture.	Sulfathiazole powder insufflated in left ear after operation caused a generalized skin rash. The continued discharge may be due to loss of sensitivity to tyrothricin, which was used at operation and at every treatment.
(Compare with No. 52, Table 1. Site of infection and organism identical with No. 48. Organism in No. 52 sensitive to penicillin, treated with penicillin; rapid cure)									
No. 52 W M 57	Mastoid (attic) right, for 6 months.	Pain, impaired hearing and discharge in right ear.	+	+	Highest temp. 99.4°F. Normal after 12 hours. Up in chair 3rd day.	Ear cleaned with dry cotton and canal filled with penicillin (full strength) daily for 10 days.	No pain. Discharge rapidly decreased. Hearing returned.	10 days after operation ear was dry. Healing rapidly and hearing good.	This patient had chronic suppuration in attic for 6 months. Local treatments. No improvement. 2-9-43: Had a modified radical mastoid operation. Abundant use of penicillin at operation and in wound for 10 days. Discharge rapidly disappeared. Ear was dry in 10 days and has remained dry (3 months). No sulfonamide used. Table 1 (No. 52) shows that his strian of staph. was killed with penicillin in a dilution 1-80, but entirely insensitive to tyrothricin.

TABLE 7—CASE HISTORIES OF PATIENTS WITH STREPTOCOCCUS INFECTION TREATED WITH TYROTHRICIN OR PENICILLIN

Case Number Table 3 Race, Sex, Age	Site of Infection	Symptoms	TREATMENT					RESULT		COMMENTS
			Local	Operation	Tyrothricin	Penicillin	Sulfonamides	Postoperative Reaction	Postoperative Treatments	Immediate Result	Last Report	
No. 3 C F 11	Frontal, ethmoid, osteomyelitis skull—orbital abscess.	Proptosis left, marked swelling lids left. Pain, fever 103.8°F. for 3 days.		+	+		+	Temp. no higher than before operation. Reached normal on 4th day.	Wound left open at operation. Was irrigated twice daily with tyrothricin 1-10,000 in distilled water for 2 weeks, then once a day for 1 week. Sulfathiazole gm. 6 q. d. for a week. Two transfusions. Intravenous fluids.	Proptosis gradually receded. Temp. normal on 4th day. No evidence of spread of infection.	Discharged on 20th day. Last seen 4 months later. Well.	2-21-43: An extremely sick child. Sulfathiazole by mouth begun on admission, given for 6 days. Operation immediately. External incision, left frontal; filled with pus—orbital abscess. Osteomyelitis frontal bone. All soft bone removed. Tyrothricin 1-5000 used freely in wound and on packs, and 1-10,000 for wound irrigation twice daily for 2 weeks. Microaerophilic beta strep. in pure culture.
No. 4 W M 28	Left antrum and ethmoid.	Nasal obstruction, pain, discharge for a month.	+		+			Irrigation left antrum tyrothricin 1-10,000 in distilled water (8 times in 2 weeks).	After first 5 irrigations no pus seen in washings.	Feels better, less discharge.	Well 2 months later. Left antrum that was dark on transillumination and x-ray is now normal.	8-12-42: Culture left antrum: heavy growth beta strep. 8-24-42: Culture left antrum: no strep. Few colonies of staph. aureus.
No. 13 C F 39	Mastoid, bilateral (acute exacerbation).	Pain, discharge, impaired hearing for 6 weeks.		+	+		+	Highest postoperative temp. 99.6°F. No wound infection. Discharge at all times after operation was very slight.	Tyrothricin 1-4000 in distilled water used freely in wound at operation and on packs. In addition sulfanilamide powder in wound at operation. Daily irrigation with tyrothricin 1-10,000.	Pain stopped. Discharge much less. Beta. strep. rapidly disappeared from cultures; staph. aureus disappeared.	11-12-42: Bilateral mastoid operation for acute strep. infection. 12-3-42: No discharge in either ear. Last seen 6 weeks later. Well.	Sulfadiazine (mouth) for a week, 6 grams a day (11-12-42 to 11-18-42). 11-12-42: Simple mastoid operation on both sides. Culture show heavy growth beta hemolytic strep. on 11-12-42. Culture shows heavy growth of hemolytic staph. aureus on 11-23-42. In addition to tyrothricin this patient had sulfonamides by mouth and one application as powder in the wound.
No. 20 W F 31	Ethmoid and sphenoid, right.	Infectious arthritis, nasal obstruction and discharge, right, for a year.		+	+	+	+	No rise of temperature after operation. Orbital cellulitis followed intranasal ethmoid operation. Promptly subsided after a week of sulfadiazine by mouth.	Tyrothricin 1-5,000 used freely in wound and on packs. Sulfadiazine (mouth) for a week after operation for orbital cellulitis.	The beta strep. soon disappeared but hemolytic staph. aureus appeared. (See Table 1 No. 55). Penicillin used for staph. aureus infection.	6 months later arthritis much better. No evidence sinus infection.	This patient had a strep. sensitive to tyrothricin. This was followed by a staph. infection—not sensitive to tyrothricin but to penicillin. (See Table 1, No. 55).

No. 21 W M 40	Frontal, ethmoid and antrum, left.	Proptosis, orbital cellulitis, severe pain for 2 weeks.	+	+	+	No rise of temperature after operation.	Tyrothricin 1-10,000 in distilled water used freely at operation on packs and daily irrigation frontal for 2 weeks.	No pain. No increased swelling of eye or lids. Some purulent discharge for 10 days.	Discharged 5th day after external incision for drainage acute frontal sinusitis and orbital abscess. Well 2 weeks after operation.	Sulfathiazole gm. 6 q. d. for 5 days because patient had acute sinusitis, orbital abscess and a pure culture beta strep.
No. 24 W F 6	Otitis media, acute.	Frequent colds, always followed by otitis media—for 3 days.	+		+	Highest temp. 100.2°F. (rectal).	Penicillin in nose and nasopharynx at operation; was used as drops in infected ear twice daily for 3 days.	Rapid cessation discharge and healing tympanic membrane, right.	Discharged on 4th day. Ear dry, hearing good, tympanic membrane healed.	Removed adenoids; radon treatment of nasopharynx. Nose and nasopharynx thoroughly washed with penicillin (full strength). Discharging right ear also filled with penicillin-soaked cotton.
No. 4 (alpha strep. chart) W M 22	Frontal, ethmoid and antrum, right.	Severe pain over right frontal for one week.	+	+		Highest temp. 100.2°F. for 12 hours; normal after that.	Tyrothricin 1-5,000 in distilled water used to thoroughly wash out frontal at operation. Then daily irrigations 1-10,000 for a week.	No swelling eye or lids. No pain after operation. After 2nd day no pus washed out of frontal sinus.	No headache. No discharge in nose. External incision allowed to close on 7th day after operation. Well.	External incision for drainage acute frontal sinus infection, right. Tyrothricin 1-5,000 in distilled water used freely at operation and on packs. Daily irrigation frontal sinus with tyrothricin 1-10,000 for a week.

TABLE 8—CASE HISTORIES OF PATIENTS WITH PNEUMOCOCCUS INFECTION TREATED WITH TYROTHRICIN OR PENICILLIN

Case Number Table 4 Race, Sex, Age	Site of Infection	Symptoms	TREATMENT					RESULT		COMMENTS
			Local	Operation	Tyrothricin	Penicillin	Sulfonamides	Postoperative Reaction	Postoperative Treatments	Immediate Result	Last Report	
No. 5 W M 30	Frontal sinus.	Pain over left frontal sinus. Nasal obstruction, left, for 1 week.	+		+		+	No operation. Irrigation frontal sinus once, and sulfadiazine by mouth.		All symptoms promptly cleared up.	Well 3 months later.	One irrigation left frontal with saline followed by tyrothricin 1-10,000 in distilled water (200 cc.) was all that was necessary. In addition took sulfadiazine (mouth) gm. 4 every 4 hours for 2 days.
No. 6 W F 32	Antrum and ethmoids, right.	Headache, right. Pain in upper teeth, right, for 3 days.	+		+			No operation. Irrigation right antrum once.		All symptoms promptly cleared up.	Has had no discharge or other symptoms of sinus infection. Well 5 months later.	One irrigation right antrum with tyrothricin 1-10,000 in distilled water (100 cc.). Thick pus washed out. A 2nd irrigation not necessary.
No. 7 W F 43	Antrum, ethmoid and sphenoid, right.	Chronic bronchitis, low grade fever, chronic sinusitis for 15 years.	+	+		+	+	Has had numerous operations on ethmoids and antra. Still has chronic suppuration and polyps. Culture: pneumococcus.			Weeks of local treatment with penicillin, irrigations and packs of no value. Not improved.	This patient's history illustrates the limitations. Am sure her chronic sinus infections can be cured only by the combination of a thorough surgical operation supplemented by the free use of tyrothricin or penicillin.
No. 8 W F 33	Antrum, ethmoid sphenoid, left.	Headache, chronic stiff neck, chronic cough and constant postnasal discharge for 8 years.		+	+			9-19-42. Ethmoid and sphenoid operation left. No elevation of temp. 9-24-42. Radical antrum operation left. Temp. 101.6° F. Normal after 12 hours.	Sinuses and left side nose irrigated with tyrothricin 1-10,000 in distilled water daily for 10 days.	Nasal operation 9-19-42. Radical antrum operation 9-24-42. First postoperative treatment 10-5-42. No discharge seen in nose or sinuses after 10-12-42.	Has had a good winter. No recurrence of old symptoms after 7 months. Well.	9-19-42: Ethmoid and sphenoid left, opened, local anesthesia. Filled with polyps and pus. Tyrothricin in distilled water (1-5,000) used freely at operation and on packs.
No. 9 W M 38	Otitis media, right.	Pain, impaired hearing right ear for 2 days.		+	+			Pain stopped after paracentesis.	External canal thoroughly cleaned and filled with tyrothricin in distilled water (1-5000) daily for 4 days.	Hearing rapidly improved and ear was dry 4 days later.	Well 6 months later.	Acute otitis media following a cold. Paracentesis and daily application of tyrothricin 1-5,000 in distilled water in external auditory canal and in nasopharynx resulted in complete cure in 4 days.
No. 14 W F 43	Antrum, ethmoid, sphenoid, right.	Has had a cold for a week. Severe pain for 24 hours	+		+			Pain stopped after irrigation of right antrum.	No direct treatment for ethmoid or sphenoid sinus infection.	Rapidly improved.	Well 6 months later.	Right antrum irrigated daily for 4 days with tyrothricin 1-10,000 in distilled water (200 cc.). No discharge seen after third irrigation.

XLVII

SIMULATION OF DEAFNESS

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The simulation of deafness may be a conscious or an unconscious act. In the first instance it represents a definite attempt to defraud. In the second it represents an abnormal state of mind. The detection of conscious simulation or malingering is a job for the otologist. The detection of unconscious simulation may also be his responsibility but its treatment lies in the field of psychiatry. Conscious simulation is always more prevalent in times of war and of great economic stress. The simulation may be used to avoid entrance to military life or it may be used to promote a discharge from military duties. Its most frequent use is to extract a pecuniary award to which the perpetrator is not entitled. This paper will concern itself only with conscious simulation.

The simulation of deafness may be unilateral or bilateral. It may be absolute or relative. The simulation of bilateral deafness is relatively uncommon but it is very difficult to detect because the patient has usually schooled himself and is constantly on his guard. He must be observed over a long period of time and at times when he does not believe himself to be under observation. He may be caught off guard by making slurring remarks or by suddenly and unexpectedly asking "how long have you been deaf?" or saying something like "you can go now," or "your pants are open," or "your slip shows."

People who have had bilateral deafness for a long time develop a remarkable tactile sense. If a loud sound such as the dropping of a dishpan occurs in the neighborhood, they will be apprised of the sound by their tactile sense and will turn around. The malingerer will not, particularly if he has been repeatedly examined.[1]

The Cochleo-Palpebral Test of Gault.[2] This test is very useful in this connection. It can be used for either unilateral or bilateral malingering and depends upon the fact that a sudden unexpected noise developed near either ear produces a slight winking movement or contraction of the eyelids in the corresponding eye if the sound is heard.

Whenever confronted by total deafness of one or both ears, the vestibular function should be investigated. This can be accomplished by the cold water caloric test if the drums are intact or by the turning chair tests. If vertigo and nystagmus can be produced by these tests, we know that total deafness is out of the question. This is based upon the fact that if disease or injury is sufficiently severe to destroy the hearing, it also usually destroys the vestibular function. With such a total and bilateral destruction of these two functions we would also most certainly expect to develop a positive Romberg reaction if the patient closed his eyes. We will also be very suspicious of the complaint of total bilateral deafness if the alleged injury has not been sufficient in degree or kind to produce such a condition.

The Barth Test.[3] The patient is requested in writing to sing a familiar song. If his rendition is musically correct he is not organically deaf in both ears.

Unilateral total deafness is much more frequently feigned than the bilateral variety. In order to unmask it the malingerer should never receive the slightest hint that he is under suspicion. The more unsuspecting and credulous the examiner may appear, the more readily and conclusively will the suspect respond to the tests. It is needless to say that before any malingering tests are tried, the condition of the external canal, the membrana tympani, and the eustachian tube should be carefully investigated and evaluated.

We are entitled to suspect aggravation of a hearing defect or simulation of deafness:

(1) If the patient makes lip movements of the spoken or whispered words but does not enunciate them or if he repeats only a single number when double numbers such as 22, 44, or 55 are given.

(2) If, while the "good" ear is really or only apparently closed, the patient does not admit hearing the accentuated whisper, the conversational voice, or the tones of the tuning forks when these sounds are produced in the neighborhood of the "bad" ear. (A whisper should be heard for a distance of at least 20 cm. and the conversational voice for at least 50 cm., when both normal ears are tightly closed with the finger.)

(3) If a patient with one normal ear does not admit hearing a tuning fork placed in the Weber position or if he states that the sound is not lateralized.

(4) If, while the examiner is doing the Weber test, the patient states that he hears the sound in his "good" ear and then states that he does not hear the sound at all when the "good" ear is closed by a finger or when both ears are occluded with a finger.

(5) If, in repeated tests by the whisper, voice, tuning forks, or the audiometer, the patient gives varying responses. However, these tests should be repeated a number of times on the same day or on successive days and the results carefully recorded for each examination.

The Stenger Test. The Stenger test, or the Bloch-Stenger test[4], is based upon the fact that if two equally activated forks of the same pitch (C^1 or C^2) are used with a person with bilateral normal hearing, only the tone of the nearer fork is heard, the tone of the other fork being absorbed or suppressed. The test is performed as follows: The eyes of the patient are bandaged. One then determines that the C^2 fork, when strongly activated, is heard at a distance of say 15 cm. from the good ear. One now brings a strongly activated C^2 fork to a distance of 5 cm. from the "bad" ear. Hearing for this fork is, of course, denied. One then brings a second strongly activated C^2 fork up to 15 cm. from the good ear. If the second fork is heard at that previously determined distance, it is proof that the other ear is at least deaf for that particular tone. If, however, the tone is not admitted until one brings the fork closer to the good ear than the other fork is from the "bad" ear or if all hearing for the fork is denied irrespective of its distance from the good ear, malingering is present. This test is based upon the observation of Politzer[6] that the perception of a tone in one ear can predominate and completely mask the same tone in the other ear.

Wells[5] has proposed a modification of the Stenger test in which only one fork is used. The stem of the fork is placed in one end of a piece of ¼-inch rubber tubing, 30 inches long and with firm walls. The other end of the tubing is closed by an olive ear piece. The patient is blindfolded. One first determines at what distance he admits hearing the strongly activated fork with his good ear. He is instructed to signify whenever he hears the same sound with either ear. With the olive ear piece now held firmly in the "bad" ear, the strongly activated fork is brought stealthily toward the good ear. If there is hearing in the "bad" ear, the intensified sound in that ear prevents the hearing of the weaker stimulus applied to the good ear. The malingerer, unconscious of hearing the sound with his good ear because of the lateralization of the sound to his allegedly bad ear denies hearing it at all with either ear.

The Lombard Test[2]. The Stenger test and its modification by Wells and the Lombard test have proven themselves particularly useful in my hands. The Lombard test is based upon the principle that in a normal individual hearing the sound of his own voice is necessary for the regulation and modulation of its tone and intensity. In this regard we are all cognizant of the loud speech and the monotonous intonation of the deaf and those with high degrees of hearing loss. A Barany noise apparatus is alternately sounded in the patient's "bad" and good ears so that he becomes acquainted with its characteristics and will not be easily startled thereby. He is then given the morning newspaper or a book and requested to read out loud and to continue reading no matter what happens. While he continues to read, the noise apparatus is started in his good ear. The patient whose other ear is really deaf will automatically raise the intensity of his voice or even shout as he continues to read. The malingerer will continue to read in an even tone or in only a slightly elevated tone of voice.

Erhard's Test[6]. This test is based upon the fact that a normally hearing ear, even though tightly closed with the finger, can hear a loudly ticking watch at a distance of three to four feet. The patient is placed in the center of a large room. The "deaf" ear is closed. The watch is brought to within six to eight feet from the normal ear and the patient is ordered to count its beats. The normal ear is then closed with the finger and the supposedly deaf ear tested. If the watch is not heard at a distance of three to four feet at which distance the closed normal ear should hear it, simulation is suspected. The same test can be performed with a conversational voice.

The Tschudi Test[6]. This test requires four aural specula of uniform size and shape, the small end of each being covered with a small piece of rubber tubing to make it fit snugly into the auditory meatus. Two of them are filled with wax. The patient stands with eyes blindfolded and the two specula not filled with wax are placed in his ears. His hearing distance for the whisper or the conversational voice, irrespective of the individual ears, is then determined while the examiner is behind him. The patient is then instructed to repeat during this or any subsequent examinations every word he hears. The subsequent examinations are carried out first with closed specula, then with open ones and again with closed ones and then with one closed and one open, etc. This procedure makes it impossible for the patient to determine with which ear he is hearing. He cannot tell if the good ear is excluded or not as he always has a speculum in each ear. Absolute quiet near the patient must be maintained and both specula in use must always be simultaneously removed and re-introduced so that he

has no clue as to what sort of a speculum is in either ear. In this way it may also be possible to roughly determine the hearing distance of the supposedly deaf ear.

The Stethoscope Test: This test is mentioned here only to condemn it. It is performed with an ordinary physician's stethoscope. After the patient has been blindfolded the ear pieces of the stethoscope are placed in his ears. The examiner whispers into the bell of the stethoscope. Either one or the other ear is supposedly excluded by either pinching off the tube which goes to that ear or by occluding the ear piece with wax. This sounds well in principle but you can demonstrate on yourself that one cannot exclude one of the ears by either of these procedures. The normal ear, even if so occluded, can still hear the whisper at the bell of the instrument. The trouble is that the ear pieces of the ordinary stethoscope do not fit tightly enough in the external meatus to prevent sound reaching the ear around them.

Becker's Test[7]. The equipment for this test consists of a piece of rubber tubing, four feet long, with an olive-shaped ear tip at each end, and a fairly loud ticking watch. The principle underlying the test is based upon the following facts. If the patient has normal hearing and the ear tips are fitted snugly into each ear, a watch pressed against the middle of the tube is heard equally well with either ear. The sound is heard binaurally and cannot be lateralized. As the watch is moved away from the middle of the tube and nearer to one of the ears, a point is reached at which the sound is lateralized to the nearer ear. At this point the hearing is monaural. The intensity of the sound in the nearer ear will completely mask it in the other ear. In most persons with bilaterally normal hearing it is sufficient to move the watch one inch along the tube in order to lateralize the sound.

The test is performed as follows: The ear piece at one end of the tube is snugly fitted into the normal ear. At about one inch from the other end of the tube, it is compressed with the watch so as to almost obliterate its lumen. If the patient can now hear the watch tick with his normal ear, one proceeds with the test. If he cannot, the watch is moved along the tube toward his good ear one inch at a time until he does hear the watch. This point on the tube is marked. Now both ear pieces are firmly fitted into the patient's ears and the tube is dropped behind his head. Now apply the watch to that portion of the tube between its center and the patient's "deaf" ear, about midway. If the patient is actually deaf, he will say that he hears the sound in his good ear. If he is malingering his loss of hearing, the placing of the watch nearer his "bad" ear masks the sound in his good

ear and he does not know what to say. He hears the sound, of course, in his "deaf" ear.

He may say that he hears nothing in which case he is exposed because if he were really deaf in one ear, he should hear the sound in the other. Or he may say that he hears the sound with his good ear. The examiner then pinches off the tube going to the good ear and if the patient persists in saying that he hears the sound in his good ear, he is again exposed.

The Wotzilka Lid Movement Reflex Test[3]. The patient is directed to look upward. The examiner stands to one side and slightly behind the patient. A high tuning fork is struck close to the "deaf" ear. The higher the tone the easier it is to obtain the reflex. If the tone is heard, a rather sharp movement of the lid of the corresponding eye takes place.

The Marx Test[3]. A Barany noise apparatus is set going in the good ear. The patient is asked if he hears the sound. If he says "yes" thinking that the good ear is being tested, he is exposed.

The Test of Nadoleczny[3]. One practices the lip reading of certain numbers with the patient. While the patient is thus engaged an assistant whispers a number into his "deaf" ear. This is done at the same time as the examiner repeats a different number with his lips. If the patient is really monaurally deaf, he does not hear the whispered number but continues to read the examiner's lips. If he does hear the whispered number he is apt to repeat it, thinking that he is still reading the examiner's lips. If the test does not work with the whispered voice, the assistant must use the same procedure with a conversational voice. In this way one can test each ear, not only for its ability to hear, but also for the relative distance at which the whisper or the voice, as the case may be, can be heard.

The Hummel Test[3]. This test requires for its performance two rubber hearing tubes, each about six feet long, equipped with an olive ear piece at one end and a bell receiver at the other, and two examiners who can whisper at about the same intensity. The patient is blindfolded and the hearing tube is first connected to his good ear. A short sentence is whispered into the tube which he is directed to repeat and does. The same procedure is then carried out on the "bad" ear. He does not repeat the sentence. One tube is then connected with each ear. One examiner then whispers a short sentence into one tube while his assistant whispers a different short sentence through the other tube. If the ability to hear a whisper with the "bad" ear is present, the patient becomes confused and cannot repeat either sentence.

Megoni's Test[8]. Megoni claims that his test is conclusive in 99 per cent of the cases. It is only applicable to patients having good hearing in one ear and claiming total deafness in the other. With the "deaf" ear tightly closed by the finger, the examiner pronounces some words in the barest whisper with his lips almost touching the good ear. The good ear is then closed by the finger and the same procedure is carried out with the "deaf" ear. While this is in progress, the finger is suddenly removed from the good ear. If the patient now declares he is unable to hear the words, he is unmasked, for even if there were deafness in one ear, he should be able to hear the words with the now unstopped good ear.

The Dölger Test[9]. In the Dölger test the blindfolded patient admits hearing the whisper or the conversational voice at a certain distance when the mouth of the examiner is turned away from him. He should then be able to hear the same intensity of whisper or voice at twice the distance if the examiner's mouth is turned toward him. In making the whisper or voice test in this manner, the patient cannot ascertain the approximate distance the examiner is away from him.

Methods have been described above for unmasking the simulation of total binaural and monaural deafness. Much more difficult of proper evaluation are those cases in which some hearing is admitted but in whom the amount and degree of the hearing loss is magnified and exaggerated. If these individuals are intelligent, they present a very difficult problem and a challenge to our skill and ingenuity. These cases should be studied with great care. A careful history must be taken to see if the "shoe fits the foot," if the alleged illness—through an accident or occupation—could produce the type and degree of hearing loss claimed.

They require a painstaking otological examination, a complete physical examination, and an exhaustive hearing examination with all the means at our disposal; namely, the voice, whispered and conversational, tuning forks, and the audiometer. A careful psychological evaluation of the patient seeks to determine his outlook on life, his relations with fellow citizens, his attitude toward his employer, whether the patient is responsive and whether he cooperates during his examination or whether he attempts to obstruct and mislead. Is he intelligent enough to understand what is required of him or does he have such a low plane of mentality that we must be guarded in our deductions and conclusions? The examiner must not only be a good otologist; he must also be a psychologist.

The surest way for catching those who are attempting to magnify an existing deafness is to use the classical voice, tuning fork, and audi-

ometer tests before and then after blindfolding the patient and to repeat them several times on the same day and on successive days. In such repeated tests a man would have to possess both a phenomenal memory and a wonderfully trained musical ear to avoid conflicting replies. Chimani[6] did this repeated testing with a watch, an accumeter or a metronome, carefully noting the distance at which each could be heard on each separate test. If the distance is always the same, simulation can be excluded. If bilateral partial deafness is alleged, the Lombard test can be tried, using the Barany noice apparatus in both ears.

Repeated tests with the audiometer will produce great variations in the graph in testing for partial bilateral simulated deafness. The patient just can't remember at what level he previously heard the various frequencies.

In our American way of life and with the legal structure under which we operate, a man is presumed to be innocent until he is proven guilty. It is no easy task to determine that a man is a malingerer. None of the above-mentioned malingering tests are foolproof. If an otologist sets out to determine whether simulation is present, he must be prepared to give a great deal of time and effort to the job. He should not condemn his patient on suspicion alone.

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XLVIII

A NEW METHOD FOR TREATMENT OF ACUTE AERO OTITIS MEDIA

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Aero otitis media is a common ailment among flying personnel, especially during the season of the acute upper respiratory infections. As has been previously described by many workers in the field of aviation medicine[1-13], aero otitis media is that condition brought about by failure of equalization of the pressures between the middle ear cavity and the nasopharynx via the eustachian tube. The pharyngeal portion of the eustachian tube is quite appropriately called the "danger zone".

A review of the happenings in the normal eustachian tube and the middle ear cavity in flight will enable one to better understand what happens when this normal physiological process is upset by an acute nasopharyngitis. The middle ear is a cavity in the temporal bone bounded on one side by the tympanic membrane and communicating with the pharynx by the eustachian tube. The eustachian canal is a short slit-like tube which normally remains collapsed and allows very little exchange of air between the back of the pharynx and the middle ear at ground level. Such minor exchange comes about by the casual yawn or the occasional swallowing act which is unconsciously performed by the groundling. As this ear ascends, the air at atmospheric pressure of 760 mm. is in a sense "trapped" within the middle ear cavity. In ascent the barometric pressure is reduced and at each successive few hundred feet above the ground level the air expands to a point where the pressure within the middle ear cavity is sufficient to force the collapsed tube open and a "squirt" of air

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brings about equalization with that in the pharynx. The tube again collapses and the same equalizing process repeats itself. A look at the ear drum in the interim between the equalization "squirts" will show it to be bulged outward slightly. When the excess of pressure within the middle ear cavity reaches approximately 15 mm. Hg., there will be noticed a sensation of fullness in the ear which is followed by a "clicking" sound and the ear drum actually snaps back to its normal position.

There is seldom any discomfort experienced in the equalizing process during ascent due to the valve-like nature of the eustachian tube which allows a rather free escape of air from the middle ear cavity to the pharynx. Such is not so when the process is reversed as noted during descent when there is a normal lag between the pressures in the middle ear and the atmospheric pressure in the pharynx. The middle ear pressure appears to have had the slight "upper hand" and is readily equalized by a mere squirting of the excess pressure from the middle ear cavity through the eustachian tube to the pharynx.

During descent the changes in the pressure in the middle ear do not occur somewhat automatically as they did on ascent and there will be need for auto-inflation of the middle ear or "blowing up the ears", as pilots commonly say. The drum is seen to be retracted between the auto-inflations, but is found to return to its normal position following equalization by auto-inflation. The process must be repeated at rather regular intervals during descent to avoid the painful effects of the increasing negative pressure if such is allowed to exist for a period of time. Auto-inflation is carried out by many familiar methods, such as pronounced swallowing, yawning, or by the Valsalva maneuver. The latter is performed by holding the nostrils closed with the index finger and the thumb and attempting to forcefully blow the breath outward through the closed nostril. Once the flier is familiar with the process of auto-inflation, he will find one method and will employ it routinely.

The process of auto-inflation becomes much more complex when there is an alteration in the nasopharyngeal portion of the eustachian tube either brought about by an acute nasopharyngitis or such as exists in the case of the dive-bombing pilot. In the inflammatory process of an acute nasopharyngitis there is congestion and swelling of the mucosa of the nasopharynx which will mechanically plug the

Fig. 1.—Position of patient for instillation of vasoconstrictor solution. Note relation of chin over external auditory meatus. This and the following illustrations are official photographs, U. S. Army Air Corps, published with permission.

eustachian opening, and the process of auto-inflation will be extremely difficult or impossible. In dive-bombing, the pressure on the pharyngeal end of the flap-valve of the eustachian tube increases too quickly to permit the individual to equalize the middle-ear pressure, because he cannot swallow or yawn often enough to keep the valve open. The pressure in the pharynx then rapidly becomes too great for the valve to be opened by the pilot's efforts. In either case the pilot will seek urgent aid for the acute, deep-seated pain in the involved ear. These symptoms are accompanied by varying degrees of deafness of the conductive type.

Aero otitis media has also been observed in fliers who have been breathing pure oxygen on high altitude flights for a considerable period, particularly if the pure oxygen is breathed until descent to ground level is reached. This condition usually appears in from four to six hours following descent. Such a condition probably results from the absorption of the practically pure oxygen in the middle ear, resulting in a decreased pressure in the middle ear. This may account for the cases of "delayed aero otitis" described by pilots after having engaged in a high altitude bombing mission.

Treatment of acute aero otitis has been limited to the application of the vasoconstrictor drugs to the nose and nasopharynx, attempts at

inflation of the eustachian tube by means of the Politzer bag or the eustachian catheter, and application of warm oil vapors to the external ear canal. It is assumed that the flier has exhausted all means of equalizing the pressures by re-ascending or by his own attempts at the Valsalva maneuver. Unfortunately, cases treated in the conventional manner have necessitated the grounding of the victim for periods ranging from three to twenty days.

Quite by accident, an afflicted officer was treated by the Proetz Displacement Method[14] and was given immediate relief from a quite acute aero otitis media. His period of grounding was four days, although the ear drum and hearing had returned to normal within the first 24 hours.

Subsequently 127 cases of acute aero otitis media were treated by this method and compared to representative groups with the condition that were treated by a vasoconstrictor alone, by a vasoconstrictor and Politzerization and catheterization, and by purely conservative methods with no attempt at equalization of the middle ear cavity pressure. These results are compared in the following table:

TOTAL CASES	CASES STAGE I	CASES STAGE II	CASES STAGE III	TOTAL TIME LOST FROM FLYING (AVERAGE)
METHOD: VASOCONSTRICTOR, POLITZER BAG, and/or CATHETERIZATION				
	28			10 Days
48		18		12 Days
			2	15 Days
METHOD: VASOCONSTRICTORS AND SEDATIVES ALONE				
	8			12 Days
12		3		16 Days
			1	16 Days
METHOD: DISPLACEMENT—WITHIN 4 TO 6 HOURS AFTER ONSET				
	58			2 Days
68		8		3 Days
			2	14 Days
METHOD: DISPLACEMENT—WITHIN 30 MINUTES AFTER ONSET				
	46			4 Hours
59		8		24 Hours
			5	14 Days

Stage I.—Marked retraction of ear drum with moderate, deep-seated pain in ear; moderate capillary injection of drum; bubbles of serum scattered over inner surface of ear drum.

Stage II.—Actual demonstrable fluid level in middle ear; marked generalized capillary injection of the ear drum.

Stage III.—Fluid level in middle ear obscured by marked reddening of ear drum; extreme pain relieved only by opiates. (In all cases: (a) Weber fork test lateralized to involved ear. (b) Marked loss of hearing acuity for low tones.)

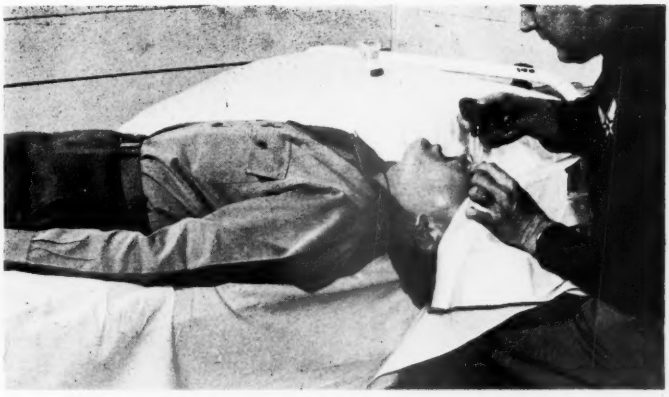

Fig. 2.—Application of controlled suction by means of Proetz Bulb. (Towel protects patient's eyes from accidental drop of solution).

THE TECHNIC OF PROETZ DISPLACEMENT[3]

STEP 1.—The nasal mucosa is shrunk by application of a suitable vasoconstrictor solution, e.g., ephedrine sulphate 2% in normal saline or Tuamine 1% in normal saline. The patient is placed in a reclining position and the solution introduced in each nostril four drops at a time, allowing approximately two minutes between applications, until twenty drops have been introduced. (Figure 1).

STEP 2.—The patient is instructed to clear the nose by gentle blowing.

STEP 3.—The patient is placed on his back with his shoulders on the edge of the bed or table, his head and neck being free in such a way that the head is invertd so that the chin and the external auditory meatuses are in the same vertical plane. While the patient is quietly breathing with his mouth widely open, 3 cc. of a weak vasoconstrictor, e.g., ephedrine sulphate ½ of 1% or Tuamine ¼ of 1% in normal saline, is slowly introduced into the upper portion of each nostril, covering the eustachian orifices in the nasopharynx.

STEP 4.—Negative pressure (approximately 180 mm. Hg.) is applied intermittently to one nostril by means of the Displacement syringe, while the operator's finger closes the other and the patient closes the pharynx by saying "kay" or "cake". This procedure is repeated for six fluctuations to each nostril and the patient is allowed to sit erect. (Figure 2).

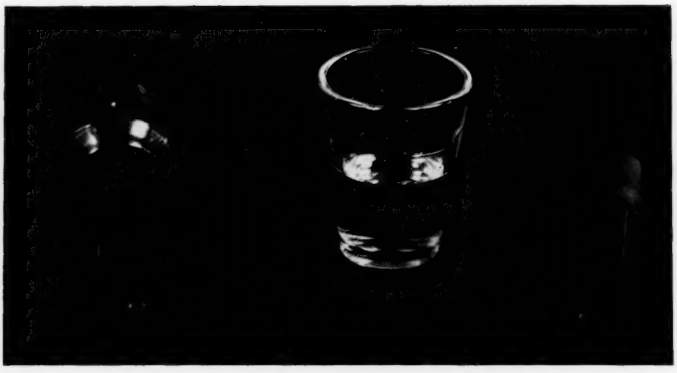

Fig. 3.—Instruments necessary for Displacement.

STEP 5.—After ten minutes to allow the vasoconstrictor sufficient time to shrink the nasopharyngeal tissues, the same instillation-suction procedure is repeated. It is usual that during this second maneuver the patient will feel the vacuum release from the involved ear and he will be able to open the affected ear at will.

STEP 6.—The final maneuver in the procedure is performed after the patient has again cleared his nose gently by blowing. This consists of instructing the patient to swallow and at the same time introducing positive pressure in one nostril with the Displacement bulb while holding the opposite nostril tightly closed with the finger. This corresponds to the Politzer method of inflation of the eustachian tube with the added features of having thoroughly shrunk the mucous membrane about the orifice of the tube, having relieved the vacuum within the middle ear, and having cleared the pharynx of secretions. This latter maneuver will serve as a final check on the patency of the involved eustachian canal.

STEP 7.—The patient is given a vasoconstrictor—usually a benzedrine or a Tuamine inhaler to use at intervals to keep the nasopharyngeal mucosa shrunk and the middle ear open.

THE PRINCIPLE—AN EXPLANATION

The application of the Displacement Method in treatment of an acute aero otitis media may be explained as follows: The obstructed pharyngeal end of the eustachian tube may be likened to a stopper part-way down an open drain of a bathtub full of water. The stopper

will exert a tug but may be easily withdrawn. The process of withdrawing is brought about first by "loosening" the stopper by use of vasoconstrictors and by then "withdrawing" it by controlled suction by the Displacement bulb.

An additional explanation concerns the alteration of the rather flaccid pharyngeal portion of the eustachian canal by the combination of the hammock muscles suspending the canal while saying "kay" or "cocoanut cake" and the simultaneous application of the negative fluctuations by means of the Displacement bulb. This alteration of the position of the canal plus the application of the suction can account for the ease of the "unlocking" of the obstructed eustachian canal and middle ear.

OBSERVATIONS

In the beginning afflicted fliers were kept grounded for not less than six days in spite of their apparent improvement or cure. Later, especially among Navigation Cadets, we routinely grounded them for a period of only 24 hours, providing the ear drum had returned to normal and the Weber test failed to lateralize to the affected side, indicating the removal of the obstructive type of deafness. More recently, pilots were allowed to return to flying and experienced no untoward effects even as soon as six hours following treatment.

A glance at the table will show the importance of the early treatment of the process. It has been observed that the process goes through the various stages from that of Stage I through Stage III, if allowed to continue untreated. Unfortunately, those severe cases that were in Stage III when first observed had existed for a period of five to six hours and little benefit was given by any of the accepted methods of treatment. The time lost from the flying line remained constantly much greater than the less severe cases.

CONCLUSIONS

A method of treating acute aero otitis media has been found that requires no instrumentation that might traumatize the eustachian orifice.

The equipment is simple and can be easily carried to the most remote outpost. (Figure 3).

There is a conservation of flying time by reducing the period of grounding from 12 days (average) by the regularly employed methods

of treatment to 1 to 2 days by the Displacement Method. This is of prime importance in the areas of tactical operation.

This method is not offered as a "quick cure" for nasopharyngitis, but the course of the nasopharyngitis has been noticeably shortened in those cases treated.

Another method of treatment has been added to the armamentarium of therapeutic methods in the field of Aviation Medicine.

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TURNER FIELD.

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XLIX

INTERRELATIONSHIP OF UPPER AND LOWER RESPIRATORY INFECTIONS

Emphasizing the Routes of Infection

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For the past tenty-five years there has been a growing realization among internists and otolaryngologists that many of the chronic and subacute diseases of the chest are dependent upon chronic or subacute infections of the nasal accessory sinuses. At first there were only a few men interested in establishing the relationship between chest and sinus diseases, but as the years have passed along, more men have investigated the close association that exists between upper and lower respiratory infections. At present it is realized by most men of the medical world that there is a relationship between sinus and chest conditions in a fair number of instances, but even now there are comparatively few doctors who know how constant is this relationship. I believe that from 85 to 100 per cent of all chronic tracheobronchitis, bronchitis, bilateral bronchiectasis and peribronchitis cases are directly dependent upon some type of chronic sinus disease, with the exception of specific types of lung infection, such as tuberculosis, syphilis of the lungs, pneumonia or lung abscesses which have resulted from foreign bodies of various sorts or the aspiration of infected tissue or material at the time of operation. Even when the lung disease occurs as a sequel of measles, whooping cough, scarlet fever or influenza, it is probable that a sinue disease exists in those cases where the trouble in the chest persists and is resistant to measures of relief directed to the chest itself.

Some recent work done and reported by Anspach[1], is most important and in my opinion is the most satisfactory explanation of unilateral bronchiectasis. He makes the following statement:

"By far the most common cause of bronchiectasis is bronchial obstruction due to thick, sticky secretions which follow infection or foreign material. The small size of the bronchi, long recumbent posture, and weak evacuation mechanism in infants predispose to prolonged bronchial obstruction. Farrell stated that 80 per cent of his patients dated their symptoms from the first decade in life. Ogilvie in

a recent article, attributed 45 of 68 cases or 66 per cent to symptoms dated from the first five years of life and in 37 of 45 to the first two years of life. It is evident that this disease starts in childhood. If a hopeless bronchiectasis is to be averted, treatment must be instituted before the dilatation of the bronchi takes place. In order to recognize the disease in its early stages the X-ray signs of atelectasis become of ever-increasing importance. It is the highly significant pre-bronchiectatic state.

"In conclusion one must not only recognize the network of shadows and the streakiness that so often indicates the presence of bronchiectasis, but he must suspect bronchiectasis as a possible future development in all cases of persistent or intermittent collapse of any portion of the lung. The most common cause of bronchiectasis is a disease process which hinges on atelectasis. This is most often recognizable in an early stage by the triangular shadow of increased density at the base of one or both lungs. If this shadow can be dissipated, bronchiectasis can be prevented. Most bronchiectasis of the lower lobe can be traced to childhood and by far the majority to the first two years of life. There is no proof that many cases called 'congenital cystic disease' have a different origin or that the changes have occurred in prenatal life. There is no reason to suspect that the bronchial dilation associated with a tuberculous lesion is dependent upon any special characteristics of the tubercle bacillus or that its pathogenesis is different from other bronchiectasis. The change from the normal lung to various forms of bronchial dilation can be readily observed on regular chest roentgenograms or bronchograms made at fairly frequent intervals. X-ray is necessary for the positive identification of bronchiectasis and for the early recognition of atelectasis which precedes bronchiectasis."

Wood[45] stated: "Evidence of secondary infection of lower portions of the respiratory tract from nasal sinusitis is too absolute to be denied. Such occurrences are too frequent to be overlooked." Hajek[15] advised the eradication of sinus disease in preference to pilgrimages to resorts in an effort to relieve the catarrhal changes in the larynx, trachea, bronchi and lungs. Dean[12] is to be quoted as follows: "In chronic bronchitis and bronchiectasis the first step in therapy is the examination of the upper respiratory tract for evidence of chronic infection." Smith[38], after reporting the study of a large group of cases from a thoracic clinic, stated as follows: "No condition of the chest should be finally diagnosed without a thorough search for the foci of infection in the head."

Chronic sinus disease must be looked upon as a constant menace to the lungs. Rist very aptly drew the comparison that exists between the respiratory and urinary tract when he said "that as cystitis is so frequently the consequence of renal infection, so is chest disease frequently the consequence of sinus disease."

Lederer[20] states that:

"Latent or so-called occult sinusitis is frequently the cause of a wide variety of diseases in remote parts of the body. Since it is well known that the mucosa throughout the respiratory tract is similar, it is not difficult to explain how infection

from the upper part of the tract may involve the lower part. The two principal routes of infection by way of the respiratory tract are through aspiration or by ways of the lymphatics. Butler believes that the former route is the more frequent one. Whelan is of the same opinion, and he, like so many other authors, testifies to the benefits of proper treatment of sinus conditions which were more or less dormant. In the final analysis, according to Smith, mechanical obstruction and infection are the essential factors in the production of bronchiectasis. If this is true, bronchiectasis can well be explained as a secondary or late complication of a preceding disease like nasal sinusitis.

"Diamond and Van Loon in a rather comprehensive review of the subject found that the incidence of sinus disease varied according to the age of the patient, being decidedly lower in infants than in older children. Co-existing sinusitis was noted in 44% of the children seen before the age of 5 years, whereas it was found in 66% of those whose condition was diagnosed at a more advanced age. Since their study was on bronchiectasis in children, Diamond and Van Loon investigated the finding of nasal sinusitis in this group as compared with those in the tracheobronchitic group. The incidence was 64% in the former and 61% in the latter. While rarely a sinusitis may not make its appearance for a long time after a bronchiectasis is diagnosed as a general rule the sinusitis if carefully sought for will be found at the time of the bronchographic diagnosis."

TREATMENT

The therapy of bronchiectasis of sinus origin resolves itself into (1) management of the sinusitis, (2) management of the bronchial disease.

In the management of the sinusitis various opinions have been expressed concerning conservative and radical measures. In children radical operative procedures on the sinuses are rarely necessary. In the group studied by Diamond and Van Loon only 3 children required radical operations, the remainder responding to conservative measures.

"Finally, the treatment of bronchiectasis resolves itself into a cooperative effort on the part of the rhinologist, bronchoscopist, internist and surgeon."

Lederer[20] concludes that:

"(1) Bronchiectasis and other forms of pulmonary disease may have their sources in one or more of the nasal sinuses.

"(2) The fact that therapy of an existing sinusitis not infrequently leads to improvement of a bronchiectasis seems to establish an etiologic relationship, more especially since it is well known that the mucosa throughout the respiratory tract is similar.

"(3) The diagnosis of latent sinusitis in the presence of bronchiectatic disease is greatly facilitated by recently perfected procedures such as the use of radiopaques.

"(4) The role of allergy in bronchiectasis must be duly considered in the light of recent observation.

"(5) If, as seems reasonable to assume, sinusitis is an important etiologic factor in a large number of cases of bronchiectasis, treatment of the latter must at the same time rationally include adequate management of the existing sinus disease."

It is my intention in the presentation of this subject to explain the various possible routes by which the infection in the sinuses can reach and involve the chest structures. It is probable that in some cases the infection has been carried to the chest by one route almost entirely, but in the greater number of cases I believe that the infection probably gets to the chest by a combination of routes.

Without going into great detail I wish to enumerate the most probable routes by which infection reaches the chest from the diseased sinuses, as follows: (1) direct aspiration of infectious material into the trachea and bronchial-tree, the so-called aspiration or droplet infect, (2) lympho-hematogenous extension, (3) hematogenous extension, and (4) direct continuity of tissue.

In 1930 and 1931 I decided that lipiodol should be recovered in the bronchial tree if it was injected directly into the sinuses instead of instilling it into the nasopharynx through a catheter inserted into the nose. I did not see why the lipiodol would not enter the trachea while the patient was awake. Accordingly, I injected the ethmoids and sphenoids with lipiodol, by the Proetz[32] displacement method, at about 4 P. M. The patient was sent directly to the x-ray room and pictures of the sinuses were made. The lipiodol was in the ethmoids, sphenoids and the right antrum, the left antrum having been almost completely obliterated by a Caldwell-Luc operation. The patient was told to avoid coughing and a sedative cough mixture, containing 1/8 grain of codein per dose was prescribed to be taken every two or three hours if necessary to control coughing. The next morning a picture of the chest was made, but no lipiodol was found in the bronchial tree. Twenty-four hours after the first lipiodol injection I repeated the same procedure by injecting some more lipiodol by the Proetz method. The patient went directly to the x-ray room again and pictures were taken of the chest. These pictures showed lipiodol in the bronchi. The lipiodol was not injected again, and twenty-four hours after the second injection, or forty-eight hours after the first injection, another x-ray picture was made, which showed the lipiodol had nearly all disappeared but there was still

some of it scattered through the smaller bronchioles. Lipiodol is certainly more irritating to the tracheal mucosa than would be the mucopurulent discharge formed from the patient's own tissues; therefore, I thought that the value of the experiment would not be impaired by asking the patient to refrain from coughing, if possible, and I gave the sedative cought mixture to help in that respect. It is true that only a small quantity of lipiodol was found in the bronchial tree, but larger quantities of mucopurulent material manufactured from the patient's own tissue would probably be retained before it would be coughed out, because the lipiodol is a foreign material and is slightly irritating. I had also shown to my own satisfaction that the material could be aspirated into the trachea while the patient was awake. I think that unquestionably this experiment proves that aspiration infection plays a very considerable part in the production of these chest complications associated with a sinus disease in which we do have a discharging type of infection. This does not mean that I am not fully aware of the frequency with which these infections are carried through the lympho-hematogenous route, but that I consider the aspiration type of infection also of paramount importance.

These experiments were carried out while the patients were going about their business, which showed that the larynx, spoken of by Jackson as "the watch-dog of the lungs," is not always effective in its effort to keep foreign materials from passing by it. The importance of the droplet infection route can be realized when it is remembered that in many patients lipiodol can be instilled into the trachea by dropping it into the pyriform sinuses from whence it will flow into the larynx, even though no local anesthetic has been used. If a foreign substance, such as lipiodol, can so easily slip by the larynx, then it is reasonable to assume that mucopurulent material, a product of the patient's own tissues, can more readily drop from the postnasal space and find its way into the bronchial tree. Spence[41] has recently reported that in x-ray pictures he has also found lipiodol in the chest after he had injected it into the sinuses. Quinn and Meyer[33] instilled large quantities of iodized oil into the nostrils of patients sleeping under morphine and sodium barbital, and by roentgenograms taken the following morning found small quantities of the oil in both lower lobe bronchi.

The lympho-hematogenous route of infection was definitely demonstrated by some excellent work done by Mullin and Ryder[28], and reported in 1920 and 1921. These men injected an emulsion of india ink and tubercle bacilli into the sinuses of rabbits and cats, and later found the ink in the submaxillary and internal jugular

lymph nodes, the larger lymph trunks, the great veins, the right side of the heart, and thence in the pulmonary arteries and peribronchial lymph nodes.

Infection from the sinuses to the chest by the hematogenous route probably is very frequent, but to my knowledge there has been no experimental work reported that would indicate how often the infection is carried directly through the blood stream to the lungs. Infection can likely reach the lungs from the nose by direct continuity of tissue, but I believe that the other routes of infection are much more important and are probably responsible for most of the secondary infections in the lungs. I believe Mullin[25] was almost correct when he stated, "In cases where there is little or no escape of pus from the antrum into the nose, I think the lymphatic route is probably the path of infection par excellence. On the other hand, in cases where the nose is constantly full of pus, it is possible that inhalation may be more important than absorption." I would alter the latter part of his statement to read that in cases where the nose is constantly full of pus, it is very probable that inhalation is more important than absorption.

Statistics from various clinics would indicate that nasal sinus disease is present in from 55 to 100 per cent of all bilateral bronchiectasis. Dunlan and Skavlen stated that 73 per cent of their cases of bronchiectasis had sinus disease, and Clerf[8] reported that about 82 per cent of his cases showed sinus pathology. Unilateral bronchiectasis is not associated so frequently with sinusitis. I believe that the association of bilateral bronchiectasis and paranasal sinus disease is almost constant, the apparent exceptions being due to an inability of the examiner to determine always the existence of sinus disease. Of course, bronchiectasis can be caused by foreign bodies, lung abscess and fibroid phthisis, but such cases are not being considered in this paper. In many instances the chest disease is much more apparent than the pathology of the sinuses.

CONCLUSIONS

In conclusion I wish to state:

First, that 85 to 100 per cent of all chronic bronchitis, bilateral bronchiectasis, and peribronchitis cases, with the exception of those due to specific lung infections, such as tuberculosis, syphilis, and those resulting from pneumonia, lung abscesses or foreign bodies, are due to infection in the upper respiratory tract which in nearly every instance is found in the sinuses.

Second, that the routes of infections have been quite positively proven, namely; (a) so-called droplet or aspiration type, (b) lymphohematogenous extension, (c) hematogenous extension, and (d) possibly by direct continuity of tissue.

Third, that practically all cases of unilateral bronchiectasis not resulting from foreign bodies tumors or specific lesions are preceded by atelectasis which occurs in infancy or childhood and can most frequently be diagnosed radiographically by the demonstration of a rather typical triangular shadow usually found in one of the lower lobes. Also that there are a few cases of bilateral bronchiectasis that can be explained pathogenically by atelectasis in childhood.

Fourth, that none of the pathological conditions of the lower respiratory tract mentioned above will respond permanently to any type of treatment unless the upper respiratory infection can be successfully taken care of.

MEDICAL ARTS BUILDING.

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L

OBSERVATIONS ON PARANASAL SINUSITIS AMONG PATIENTS SUBJECTED TO LOBECTOMY FOR BRONCHIECTASIS

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The simultaneous occurrence of infections in different parts of the respiratory tract is commonly observed by all physicians. The common cold provides the most frequent instance of this relationship, but it is also noted in the more severe acute infections. Chronic infections of the air passages are more prone to remain localized in one region than are acute infections, although multiple loci of chronic infection in the air passages of one person are a frequent occurrence. The most obvious reason for the presence of infection in more than one part of the air passages is the continuity of the airway, which provides a broad highway for the transfer of infected secretions from one region to another. A notable exception to this rule is pulmonary tuberculosis, which rarely extends to the upper part of the respiratory tract. Suppurative infections of the lungs and bronchi show a definite tendency to extend to the upper air passages through the medium of infective materials expelled from the bronchi into the throat and nose during the act of coughing, and conversely chronic infection of the paranasal sinuses is often accompanied by chronic pharyngitis and bronchitis. Simultaneous involvement of multiple regions in the respiratory tract by severe acute infections is an important factor in the development of multiple loci of chronic infection.

HISTORICAL ASPECTS

The association of bronchiectasis and chronic sinusitis has been noted by many observers. There has been considerable divergence of opinion among writers on the subject of the interrelationship of the two diseases and their etiologic effect on one another. Campbell[1] stated that sinusitis invariably accompanies pneumonia in childhood. Mullin[2], in 1921, described two routes of extension of infection from

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the sinuses to the lungs: (1) the lymphatic drainage of the antrum via the submaxillary and deep cervical nodes to the great veins, the right side of the heart and thence to the lungs, and (2) the inhalation route. Mullin stated that bronchitis and sinusitis develop spontaneously, and that sinusitis causes continued bronchitis which leads eventually to the development of bronchiectasis. He also stated that "The theory that sinus disease may develop from bronchitis is extremely improbable since there is no ready route from the bronchi to the sinuses." In support of his contention that bronchiectasis is secondary to sinusitis he cited the rare incidence of tuberculosis in the nose in cases of open pulmonary tuberculosis. The importance of lymphatic drainage from the sinuses in the causation of bronchiectasis is open to question, for if this hypothesis is true, why then does not bronchiectasis develop in cases of chronic suppuration in any part of the body from which lymphatic drainage enters the general circulation?

Quinn and Meyer[3] reported studies in which the lungs of five of eleven sleeping patients were filled with iodized oil applied by a nasal catheter, and expressed the opinion that the swallowing reflex is inhibited during sleep. Oil did not reach the lungs in six cases in which the patients slept lightly or awakened and swallowed when the oil was instilled. Quinn and Meyer stated, "It is the belief of some that the sinusitis may be secondary to bronchitis or bronchiectasis, but the great majority believe that the opposite is true or that their onset is simultaneous with some acute infection." Hodge[4] placed iodized poppy seed oil in the trachea and had the patient cough. In only three of ten cases could oil be demonstrated in the nasopharynx and in no case was oil found in the nose. Hodge suggested that the problem be considered as infection of the entire respiratory tract. Schenck[5] repeated the foregoing studies using as subjects children under anesthesia for tonsillectomy and adenoidectomy. Iodized oil placed in the nose reached the lungs in ten of twelve cases. In the other two cases anesthesia was very light. When the oil was dropped into the trachea, in three of six cases in which the patients coughed there was oil in the nasopharynx and in one of these cases oil was demonstrated in the nose. The results of these studies indicate that the pharyngeal reflexes play an important role in preventing extension of infection along the respiratory tract.

Clerf[6] divided cases of bronchiectasis into two groups: (1) bronchiectasis commonly associated with disease of the nasal accessory sinuses, including cases in which the history of productive cough dates back to an infection of childhood or to influenza; (2) bronchiectasis commonly unassociated with disease of the nasal accessory sinuses,

including cases in which bronchiectasis follows bronchopneumonia, lobar pneumonia, pulmonary abscess or foreign body. In this group sinusitis is uncommon "even in the presence of a suppurative focus attended with profuse purulent expectoration which is projected into the postnasal space during severe paroxysms of coughing."

Perry and King[7] expressed the belief that sinusitis is merely an associated condition with bronchiectasis. In their opinion patients suffering from bronchiectasis have a lowered resistance in the respiratory tract, and therefore, frequent colds. Review of their cases showed the degree of sinusitis to be closely related to colds in the head. "A patient who raises a large amount of sputum invariably coughs some through his nose and here is at least a potential source of infection for the sinuses which may reverse the cause and effect theory."

The high percentage of cases of bronchiectasis in which sinusitis also is present has been cited in support of the hypothesis that bronchiectasis is secondary to sinusitis. Quinn and Meyer[3] in a review of the literature on this subject quoted several series of cases. Kistner noted sinusitis in 97 per cent of 196 cases, Dennis in 90 per cent of 52 cases and Dunham and Skavlen in 73 per cent of 28 cases. In their own series, in 58 per cent of 38 cases of bronchiectasis there was sinusitis. Moersch[8] reported the presence of sinusitis in only a third of 245 cases of bronchiectasis.

It is a common observation that bronchiectasis does not occur frequently in cases of chronic sinusitis. I have not seen a report of the incidence of bronchiectasis among patients who had chronic sinusitis.

MATERIAL USED IN THIS STUDY

A series of 405 consecutive cases in which chronic sinusitis was diagnosed at the Mayo Clinic were reviewed and the incidence of bronchiectasis was noted. Only cases in which the history indicated the presence of sinusitis for longer than one year were considered and these were arbitrarily divided into three groups according to the duration of the disease. Of the entire series, symptoms of sinusitis had been present for a period of one to five years in 212 cases, five to ten years in 60 cases and more than ten years in 133 cases. The diagnosis of bronchiectasis was also recorded in 23 (5.7 per cent) of the 405 cases. Analysis of the 23 cases in which sinusitis and bronchiectasis both were present revealed simultaneous onset of the two conditions in 11 cases. Symptoms of sinusitis preceded chronic productive cough in 2 cases. In 10 cases the time of onset of one of the two conditions was not definitely noted in the history. In no case was there a clear

history of bronchiectasis preceding sinusitis. In 11 of the 23 cases the history definitely indicates that the onset followed pneumonia or the acute diseases of childhood.

In both cases in which history of nasal discharge preceded that of productive cough, pulmonary difficulties had been present at the time of onset of the nasal discharge. One patient, aged 43 years, had pneumonia twice in infancy. Influenza and pneumonia at the age of 26 years were followed by nasal discharge and occasional cough. Cough had been constant since influenza and pneumonia at the age of 40 years. The other patient, aged 14 years, had had nasal discharge since birth. Pulmonary collapse had been noted when the patient was four days of age. Chronic productive cough had been present for four months preceding the examination.

The analysis of this small group of cases in which sinusitis and bronchiectasis coexisted does not indicate that either sinusitis or bronchiectasis predisposes to the development of the other condition, but suggests that the two conditions may arise simultaneously in the same person, often as a result of severe acute infection involving the entire respiratory tract.

Sinusitis and bronchiectasis, when coexistent, represent loci of chronic suppuration at the two extremes of the respiratory pathway. Once two such loci of suppuration are established in the airway of one person, both clinical and experimental observations indicate a definite interrelationship between the two. Disregarding the lymphatic drainage from the sinuses to the lungs as described by Mullin[2], Mullin and Ryder[9] and Larsell and Fenton[10], there remains the anatomic continuity of the air passages to provide a channel for transfer of infected secretions from one diseased region to the other, as demonstrated by the experiments of Schenck[5] and Quinn and Meyer[3]. The transfer of infected secretions along the respiratory tract makes it obvious that each source of infection aggravates the other and that success in treatment cannot be expected unless the amount of discharge from each is materially reduced.

Treatment of sinusitis in cases of combined sinusitis and bronchiectasis is accepted as a valuable adjunct by most writers on the subject. Mullin[2] cited a case in which a boy, aged 10 years, recovered from bronchiectasis after surgical treatment of infected sinuses. Clerf[6] wrote that "If there is concomitant infection of the nasal accessory sinuses the patient should be treated for this first. If he has not been treated, the sinus infection, irrespective of its original etiologic significance, unquestionably exerts an unfavorable influence on bronchi-

ectasis." Clerf[11] also stated that the best results from treatment of sinuses come in children, but warned that direct medical treatment of bronchiectasis must be practiced at the same time to secure notable benefit. Dennis[12] reported a series of 25 cases of bronchiectasis in which treatment of sinusitis resulted in improvement or temporary improvement in 16, and no improvement in 4. Results were not noted in 5. He noted a tendency for primary improvement followed by gradual relapse of bronchiectasis but felt that enough patients were relieved to warrant continued efforts to cure the sinus disease by operation. His best results were in early cases. Dennis stressed the necessity of thorough operation. Goodale[13] expressed the belief that treatment of sinusitis is advisable to reduce reinfection of the lungs from above and to reduce the total load of infection carried by the patient.

In Ogilvie's[14] opinion infection goes in both directions and sets up a vicious cycle. He did not note improvement in bronchiectasis after treatment of sinusitis in his patients. Ogilvie wrote that "It would appear that the most reasonable attitude for the future is to search for sinal infection in all cases of bronchiectasis in which operation (lobectomy) is to be performed and to deal adequately with such infection after operation in order to prevent further damage."

I have observed that the results of treatment of sinusitis were poor in the presence of bronchiectasis. The early postoperative course is one of considerable improvement in the condition of the sinuses with definite decrease of, or complete relief from, purulent discharge in the nose. After cessation of postoperative treatment, however, the tendency is toward a gradual return of the purulent nasal discharge in a large proportion of cases. The recurrence of purulent discharge is accompanied by the redevelopment of a thickened, pyogenic membrane within the sinuses, nasal polypi and hyperplasia of bone elements, which result in obstruction or closure of the drainage pathways from the sinuses which were created at operation. Reinfection of the sinuses after adequate operation is the result of the repeated discharge of infected secretions from the lungs into the nose during paroxysms of coughing and is but another demonstration of the difficulties which attend the treatment of infection of rigidly walled cavities.

If it were feasible to ablate the cavities of the paranasal sinuses completely, it should be possible to eliminate sinus infection successfully in the presence of repeated reinfection from below. While the frontal sinus can be collapsed completely by operations of the Killian type, and while the ethmoid labyrinth may be converted into one

smooth walled cavity if the middle turbinate is sacrificed, the attendant deformity and loss of function from such radical procedures is sufficient to limit their use. The anatomic situation of the maxillary and sphenoid sinuses effectively prevents elimination of pockets in which reinfection may take place. Since it is impossible to eliminate the cavities of the sinuses, it is not likely that surgical procedures can ever make the sinuses immune from reinfection.

In certain cases of bronchiectasis, those among young persons, and those in which the disease is limited to a small portion of the lung, the condition may be successfully treated by surgical removal of the diseased portion of the lung. Following removal of the diseased lobe or lobes of the lung, there is immediate cessation or marked decrease of productive cough, dependent on whether all of the bronchiectasis was eliminated by operation and on the degree of chronic bronchitis present in the remaining lung. After lobectomy the prospect of successful treatment of sinusitis is improved to a degree proportional to the reduction of productive cough.

REPORT OF CASES

CASE 1. A man, aged 22 years, registered at the Mayo Clinic May 28, 1942. His presenting complaint was headache and nasal discharge of five years' duration. The symptoms had been more noticeable in cold than in warm weather. He denied any other difficulties. Examination of the nose revealed purulent discharge from the right middle meatus, the mucous membranes were red and congested and the nasal septum was moderately deflected to the right side. Roentgenograms of the paranasal sinuses revealed a thickened membrane and possible polypoid hyperplasia of all sinuses. The frontal sinuses were undeveloped. General physical examination did not reveal any abnormalities. The chest was negative to physical examination, and stereoscopic roentgenograms were reported negative.

On May 30, 1942, a bilateral intranasal operation was performed while the patient was under local anesthesia. The ethmoid cells were exenterated and the sphenoid sinuses were entered through the posterior ethmoid labyrinth. The middle turbinates were preserved with the exception of the anterior tips which were removed for better drainage. Large windows were placed into each antrum through the inferior meatus and the lining membrane was removed by curet.

The patient had an uneventful convalescence. He was dismissed June 18, 1942, at which time no purulent secretion had been noted for four days.

The patient returned September 9, 1942, stating that the purulent discharge had recurred two weeks after his previous dismissal. The headaches had not recurred. Examination revealed purulent discharge from both sides of the nose. All sinuses remained well open but the lining membranes felt thickened to the probe. Polypoid membrane was present in the right middle meatus. Conservative treatment was instituted for one week without benefit.

At this time the patient was closely questioned concerning cough and thoracic symptoms. The additional history obtained indicated that he had suffered from a chronic productive cough for 11 years, the onset of which followed severe whooping cough. He stated that he expectorated two to three fluid ounces (60 to 90 cc.) of greenish-yellow sputum daily. The diagnosis of bronchiectasis had been made five years previous to our examination.

Physical examination of the chest again gave negative results, although repeated roentgen examinations revealed evidence of bronchiectasis at the base of the left lung. Diagnostic studies with iodized oil revealed bronchiectasis limited to the lower lobe of the left lung. Bronchoscopy revealed pus from the bronchus of the left lower lobe and a moderate degree of secondary bronchitis.

A left lower lobectomy was performed October 3, 1942. Following lobectomy there was spontaneous decrease of the nasal discharge. Conservative treatment to the nose was instituted after the patient was out of bed. As the time of his dismissal, November 13, 1942, the nose was free of secretion with the exception of a small amount of mucus from the left side.

The patient returned for observation April 14, 1943. His cough had improved and produced very little pus. Some nasal discharge persisted. He had regained his original best weight. The patient had worked in Washington, D. C., during the winter and had spent two hours daily on crowded street cars and busses. He had suffered frequent acute infections of the upper part of the respiratory tract during this period. At this time the nasal mucous membrane was of normal tone and color. The sinuses remained open, although pus could be washed from each antrum. After five days' treatment the purulent secretion decreased in amount.

The patient was advised to seek a warm, dry climate for a period of several months. Because of spontaneous improvement during adverse conditions in the winter months, it was felt that the sinus infection would clear up under more favorable environmental conditions.

This case illustrates the recurrence of sinus suppuration in the presence of chronic productive cough. When the cough was reduced by lobectomy spontaneous improvement, but not cure, of the sinus suppuration followed. That the suppuration was not cured was due, I feel, to the re-establishment of pyogenic membrane within the sinus cavities. Under conditions favoring repeated infections of the upper part of the respiratory tract moderate infection persisted in the sinuses despite adequate anatomic drainage and ventilation. The clinical course suggests that more favorable environment will result in eventual, though delayed, cure of the paranasal sinusitis.

CASE 2. The patient, a man aged 18 years, had suffered from chronic productive cough since he had mumps, measles and whooping cough at the age of seven years. Diagnosis of bilateral bronchiectasis was made at the clinic when he was eight years of age but the diagnosis was not proved by oil studies. Bronchoscopic examination at this time revealed pus from the left main bronchus. Rhinologic examination was not done at this time.

The patient next registered at the clinic June 10, 1942, complaining of chronic productive cough. At this time physical examination of the chest gave negative results. Stereoscopic roentgenograms were interpreted as showing bronchiectasis at both cardiophrenic angles. Pus was observed from both main bronchi by bronchoscopic examination, more from the left than from the right. Bronchograms using iodized oil revealed extensive cylindric bronchiectasis in the left lower lobe. The right lung was well filled but did not show any bronchial dilatation. Rhinologic examination June 12, 1942, did not reveal the presence of pus in the nose. A high septal deflection to the left was noted. Roentgen studies at this time revealed thickened membrane of all sinuses.

A left lower lobectomy was performed July 23, 1942.

The nose was again examined August 28, 1942. Pus was observed on each side but the mucous membranes appeared normal. The patient returned October 29, 1942. On this occasion pus was washed from both antrums. He was then treated conservatively for two months without appreciable improvement in the condition of the sinuses. On December 19, 1942, a bilateral intranasal operation was done on the frontal, ethmoid, sphenoid and maxillary sinuses. Pus was found in all except the frontal sinuses. Following operation the patient was observed periodically until April 12, 1943. All sinuses on the right side and the left sphenoid and maxillary sinuses became dry promptly and remained free of secretion. Postoperative treatment of the left frontal and ethmoid sinuses was not satisfactory because of obstruction from the high deviation of the septum and purulent secretion continued to be present in this region.

In this case there was no improvement in the sinusitis following lobectomy, and improvement was not noted following conservative treatment. Following operation there was prompt cessation of purulent discharge from all sinuses except the left frontal and ethmoid, which were not adequately drained, and there has been no evidence of recurring infection in the other sinuses. A submucous resection of the nasal septum should result in complete recovery from sinusitis. The chronic cough has been markedly decreased since lobectomy.

CASE 3. A girl, aged 14 years, registered at the clinic April 12, 1943. The history revealed that from the first few months of life she had frequent infections of the upper part of the respiratory tract. At the age of two years she had had severe diphtheria. When three years of age she had whooping cough associated with convulsions. Following this she had a chronic productive cough, worse in winter than in summer. At the time of examination she raised approximately one cup of sputum daily. From the age of seven years she had suffered from constant, clear nasal discharge and during the winter months from recurrent attacks of malaise with elevated temperature up to 103°F. Both ears had discharged periodically since diphtheria at the age of two years.

Examination revealed a thin, well-developed girl who had clubbing of the distal phalanges of the hands. Physical examination of the chest gave essentially negative results. Stereoscopic roentgenograms of the chest were interpreted as apparently showing bilateral bronchiectasis, more marked on the left than on the

right. Diagnostic studies with iodized oil revealed bronchiectasis of the right middle and left lower lobes of the lungs. The disease was more extensive in the right middle than in the left lower lobe. Pus was observed in both main bronchi at bronchoscopic examination. Examination of the ears revealed dermatitis of both external auditory canals but the tympanic membranes were normal. Profuse mucopurulent secretion was noted in each side of the nose. The nasal mucous membrane was congested. Roentgen examination revealed slightly thickened membrane in all sinuses, most marked in the left antrum.

The middle lobe of the right lung was removed April 22, 1943. The patient made a rapid recovery from the operation and decrease of nasal discharge was noted while she was still in the hospital, although she did not have any treatment to the nose. The nose was observed daily for three days after the patient left the hospital. The mucous membranes were of good tone and normal color. No secretions were observed. Shrinkage of the mucous membrane by the Dowling pack method using a 25% solution of mild protein silver produced only a clear mucoid secretion, and no pus was seen after intermittent suction.

The patient had chronic rhinitis with minimal change within the sinuses. The early spontaneous relief from nasal discharge following lobectomy indicates that the nasal discharge was secondary to, and dependent on, infective materials thrown into the nose during paroxysms of cough.

CONCLUSIONS

Review of the literature indicates that bronchiectasis may be the result of chronic sinusitis, or that the two infections may arise simultaneously as the sequel of severe, acute infection of the entire respiratory tract. Experimental and clinical evidence demonstrates the transfer of secretions from one part of the respiratory tract to the other. The incidence of sinusitis among patients who have bronchiectasis is much higher than is the incidence of bronchiectasis among patients who have chronic sinusitis.

Treatment of chronic sinusitis in the presence of bronchiectasis is unsatisfactory because of reinfection of the sinuses by secretions expelled from the lungs by coughing. After lobectomy the prospect of successful treatment of sinusitis is improved. It has been my conclusion, therefore, that in cases in which there are both sinusitis and bronchiectasis and which are suitable for lobectomy, surgical treatment of the sinuses should be deferred until after the removal of the diseased lung.

MAYO CLINIC.

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LI

NONSURGICAL ASPECTS OF TREATMENT OF ACUTE LARYNGOTRACHEOBRONCHITIS

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It is expected that the term "nonsurgical" in the above title will be received with some skepticism by those best informed on the subject, because presumably surgical intervention will always be a necessary part of the management of acute laryngotracheobronchitis, at least in late or neglected cases. For many years I have myself been at pains to emphasize the importance of early and adequate surgical management of these cases, and so have most other writers on the subject. In spite of that, I am convinced that there is much to be gained by avoiding surgical intervention in the treatment of acute laryngotracheobronchitis where legitimately possible, and I therefore present this discussion of its nonsurgical aspects.

Since 1918, when I first encountered the disease which I later, in 1924[1] and 1928[2], described under the name of acute laryngotracheobronchitis, I have been very definitely convinced that the mortality entailed by it would be greatly reduced when methods of treatment were made available whereby instrumentation could be avoided.

Acute laryngotracheobronchitis manifests itself most frequently in young children during the seasonal respiratory epidemics. It is first characterized by the presence of laryngitis with moderate fever, dry cough, subglottic inflammatory edema and partial laryngeal obstruction. As the disease goes on, tracheobronchial inflammation and edema develop, with exudation of thick, tenacious secretions. As laryngeal obstruction progresses, the cough lessens, sometimes disappearing entirely, the temperature drops, sometimes to subnormal, and what I long ago termed "pale cyanosis" develops as a result of suboxygenation and cardiac and circulatory exhaustion from prolonged, violent respiratory effort (respiratory shock).

If the laryngeal respiratory difficulty is relieved by timely surgical intervention, the patient improves symptomatically and the temperature rises rapidly because of renewed oxygenation. But edema and exudation are still present in the trachea and bronchi and may later

result in bronchial plug formation and obstruction. If this happens and is unrelieved, the termination is death from exhaustion, obstructive atelectasis, pneumonia, or all three. If prompt bronchoscopic removal of bronchial accumulations is done, as it invariably should be, improvement is again noted, but the inflammatory edema continues, with exudation, and the plugs may frequently recur, necessitating repeated bronchoscopies. And even in spite of repeated bronchoscopies the patient may still fail to recover because of obstruction in the smaller bronchi, with the terminal developments just mentioned. Toxemia seems usually to play a somewhat secondary role, although it is, of course, often a factor, especially in those cases which terminate in pneumonia.

The extreme gravity of this disease, even after a free airway has been established by tracheotomy, is borne out by the high mortality rate among tracheotomized laryngotracheobronchitis patients. This is evidenced by a maximum rate reported by Richards[3] of 100% (of 5 cases, although in a later report of 23 cases Richards[4] reports a mortality rate of only 50%), a rate of 80% as reported by Neffson and Wishik[5], 75% as reported by Gilbert et al[6], 61.5% in my own reported series[2], 60% as reported by Gittens[7], 41.7% as reported by Brennemann et al[8], 40% as reported by Brighton[9], 33% as reported by Smith[10], and 31.25% as reported by Orton et al[11].

Intelligent management of disease must, of necessity, be founded upon a reasonable conception of etiology and pathology. In 1928 I[2] called attention to the fact that acute laryngotracheobronchitis cases were seen most frequently during seasonal epidemics of respiratory tract infection, and my bacteriological findings were then and have always been confusing, because of the variety of organisms encountered. In 1936, in a discussion of a paper by Gittens[12], I expressed the opinion that the basic cause of acute laryngotracheobronchitis was the filterable virus of influenza, and my conviction has been strengthened by results of treatment based on it. Brighton[9], in 1940, called attention most interestingly to an almost identical disease of chickens: infectious laryngotracheitis. Beach[13] has demonstrated that, while many organisms are to be found in the secretions in this disease of fowls, the actual cause is not bacterial but is a filterable virus, and there now exists a successful virus vaccine for use against infectious laryngotracheitis in chickens. In his paper Brighton therefore suggests that acute laryngotracheobronchitis in humans is "the result of a virus infection with secondary invasions of the various bacteria which we have found."

There has always been wide agreement on the pathology of acute laryngotracheobronchitis, and the subject has been thoroughly covered in several of the papers to which reference has already been made and which are listed in the appended bibliography. For the present purpose it seems unnecessary to go into a discussion of numerous details. It is enough to say that the outstanding pathologic change, already indicated herein, is mucosal and submucosal inflammatory edema. This edema is most marked in the looser connective tissue of the subglottic space, but extends throughout the trachea and bronchi in most cases. Late lesions of a more destructive nature have frequently also been described, even with extensive areas of necrosis in the mucosa and submucosa, but the primary pathologic change is that of inflammation with edema.

Instrumentation. While early surgical relief of the laryngeal dyspnea saves the patient from the exhausting effort of breathing against a major obstruction, this necessary surgery unquestionably predisposes to later complications in the lower air passages. I firmly believe that if there were never any instrumentation there would never be any plug formation in the main bronchi. Of course, even without instrumentation of any sort, complete obstruction from inflammatory edema in the smaller bronchi and bronchioles may occur, especially when aided by the grayish, adherent false membrane which is superimposed on the typical edema somewhat late in the disease, but I have yet to find primary bronchial plugs. This is sharply emphasized by Richards[4] in one of his case reports. His patient died of the disease without the benefit of any instrumentation whatever. Says Richards:

> "This case is of particular interest since it is the only one in our recent series in which no operative measures for relief of obstruction were carried out. This patient, seen several times by the local physician, was finally rushed to the hospital as a desperate emergency and died before arrival . . . The pathologist stressed in this case particularly the complete absence of crusts or accumulations within the tracheal or bronchial lumen and the high degree of obstruction resulting solely from the constricting edema of the walls of the larger and smaller airways. This finding, of course, lends some support to the theory first advanced by Baum that tracheotomy, by permitting the direct exposure of the tracheal exudate to the air, is instrumental in the formation of the tenacious and obstructing crusts."

The plugs have always, in my experience, with the exception of one case following intubation, appeared after tracheotomy. I have made a careful search of the literature, and, unless inadvertantly missed, there is not one case reported in which bronchial plugs were found preliminary to tracheotomy. When opened, the trachea is almost uniformly filled with accumulated secretions, which are some-

times somewhat thickened and even clotted, but no one has reported primary plugging of the bronchi. In Richards' case, just quoted, postmortem study revealed no plugging of the bronchi, even though it did reveal all the typical pathological changes. It could, of course, be said with some logic that without tracheotomy the patient dies before the plugs have time to form, but while this would certainly be often true, I cannot believe that it applies so generally as to explain the fact that plugs are never found before tracheotomy.

It is, of course, significant that tracheotomy cases of other types are not characterized by plug formation, no matter how long the tube may be worn. But that observation only serves to emphasize the fact that laryngotracheobronchitis causes serious alterations in function of the tracheobronchial glands and in the character of their secretions. These alterations make the glands and the secretions more susceptible to adverse influences, such as the drying effect of the direct blast of even warmed and moistened air through the tracheal cannula. The warming and moistening, it has been argued by Brennemann[8], effectively substitutes for normally respired air. But I am not at all sure of that, or that warmth and moisture are the only factors involved. I do know that bronchial plugs form after tracheotomy in very many cases and with extreme rarity after intubation, and seem never to form in the absence of instrumentation. I know also, from personal experience, that they frequently cease forming when the tracheotomy tube is corked and intubation is substituted. Nor is tracheotomy by any means without risk in itself, as brought out by Neffson[14] in a paper dealing with pneumothorax and mediastinal emphysema after tracheotomy.

Also, absolutely necessary as they may be, repeated bronchoscopies and aspirations are not without damage to the infected, inflamed and edematous mucous membranes of the lower respiratory tract. Obstructive secretions and plugs must be removed, but instrumentation is certainly responsible for a certain amount of irritation and reaction, with increased swelling of the bronchial mucosa and further exudation and plug formation.

Human Immune Serums. When acute laryngotracheobronchitis patients are first seen, if the condition has not yet progressed to a critical stage, prompt treatment of the infection itself should be the first consideration. For this purpose, the treatment of choice is specific convalescent human serum. This means that the serum to be used should be derived from a donor, usually some member of the patient's family, who has recently recovered from (presumably) the same infection. This is often quite practical, as young children are most

frequently the sufferers from this disease, and the child usually acquires his basic infection, probably influenza, from a member of the family to whom he has been exposed. Or the infection may have traveled through several members of a family before affecting the child with its more serious and violent manifestations. Thus it is often feasible to trace the source of infection to an individual who has recently recovered, and it is then easy to procure blood from that donor, separate the serum by clotting and centrifugation, and promptly administer the same. Every hospital laboratory is equipped to render this service, and no description of its technique is required. Depending upon the size of the recipient, from 50 cc. to 200 cc. should be administered, preferably intravenously, but subcutaneously or intramuscularly if preferred. Repeated doses are, of course, entirely permissible when needed.

If a satisfactory contiguous donor is not available, then it is perfectly feasible to administer pooled human immune influenza serum. This serum is, of course, easily available from innumerable recently recovered individuals during and after any seasonal epidemic of influenza, such as exists to some extent in every community during certain seasons of each year, and a stock of it should be kept on hand in every pediatric hospital. As an adjunct, in many cases, or as a substitute if for any reason no convalescent influenza serum is to be had, it is advantageous to administer pooled human anti-streptococcic (scarlet fever) convalescent serum. This latter is always available and I have demonstrated clinically, on many occasions, that it is highly beneficial. It may be said that its benefit is explained by the fact that many of these infections are not only primarily influenzal but, secondarily, streptococcic. That is undoubtedly true, as my own bacteriological studies indicate, and it may be the sole explanation, but I am inclined to believe that the beneficial effects are also explained by the fact that most adult human serum contains at least some influenza virus antibodies.

In summary, it should be emphasized that it is always desirable to administer immune human serum in these cases, whether early or late, or before or after other measures have been instituted, including surgical intervention. The use of serum hastens convalescence and lessens the incidence of complications. When available, specific influenza convalescent serum is preferred. If not available, then pooled human influenza convalescent serum should be used. If that is not available, or, indeed, in severe cases as an adjunct, human anti-streptococcic (scarlet fever) convalescent serum should be used. These should be given in comparatively large doses. They are harmless and

the disease is desperate. Therefore, chances should not be taken with inadequate dosage.

The details of preparation and administration of immune human anti-streptococcic serum have been discussed in other papers[15-17] and therefore will not be entered into here. The same technique is applicable to the preparation of immune human anti-influenzal serum. I realize that there are a variety of types of influenza, and immunity to one is no guarantee of immunity to another. Also, not every individual seems to be able to acquire a high level of immunity to influenza, and therefore all are not good donors. Nevertheless, this method of treatment of the actual infection in these cases is the most practical and the most promising I have tried and, since it is so often efficacious, it is worth using until something better presents itself.

Humidified Oxygen. It needs scarcely to be mentioned that in every case of acute laryngotracheobronchitis, when any respiratory difficulty whatsoever is present or even threatened, the patient is immediately put into moist, cool oxygen. Its advantages are so great and so apparent that a discussion of them will be omitted. I know of no disadvantage, and the time gained by this simple procedure is often sufficient to permit other measures to exert beneficial effects in time to avoid instrumentation.

Hypertonic Human Plasma. Those who have had wide clinical experience well know that patients are often almost in extremis when first seen with acute laryngotracheobronchitis and that, therefore, time is not then afforded for preparation or trial of immune convalescent serums. Prompt relief of the respiratory obstruction must here be the first order of business, with all other therapeutic measures left to follow. To meet this situation without surgical intervention I have initiated a very simple, safe and surprisingly effective method of dealing with the subglottic and tracheobronchial obstructive edema, which is in these cases the factor of immediate importance. This method has been described in a previous paper[15]. It is predicated upon the use of hypertonic human plasma (or serum) intravenously. The plasma comes in the usual dry (lyophile) form, prepared by freezing and evaporation, and is available commercially and in certain serum centers. Instead, however, of restoring it to its full volume, which is the usual procedure in common use, only one-fourth of the normal volume of water is added. This results in a mixture which contains four times the normal proportion of plasma protein. It is hypertonic and can be injected intravenously in that form with perfect safety. Its purpose is to reduce the edema in the subglottic and tracheo-

bronchial mucosa and submucosa. Introduced intravenously the concentrated plasma proteins, by their osmotic action, draw the fluid of edema from the tissues into the blood stream, thus immediately relieving the obstruction.

Details of preparation and administration of the four times concentrated plasma are given in the paper already referred to[15] and will not now be enlarged upon. It is enough for the present purpose to say that an initial dose of from 25 cc. to 40 cc. is usually sufficient and that its administration can be repeated as often as necessity requires, although repeated doses are seldom necessary, especially if the other measures outlined are promptly instituted. It should be mentioned that the intravenous use of hypertonic plasma for the reduction of other types of edema is well established, and reference to the work of Muirhead and Hill[19], Aldrich et al[20], Hughes et al[21], and others is suggested.

The objection is sure to be raised that frequently the condition of patients does not permit even the brief delay involved in the reconstitution and injection of the dried plasma. This is to some extent true, but the gap can often be bridged without injury if a sincere effort is made to do so. In the less severe cases, immediate resort to the oxygen tent, or room, will often suffice. In others, gentle suction through the laryngoscope, plus the oxygen tent, will relieve threatening dyspnea while the plasma is prepared. In still more desperate cases, temporary intubation with a very small bronchoscope, or even with a smaller metal suction tube, will give the necessary respite. It is true that the more desperate these cases are, the more urgent is the need for immediate relief, and it is certainly not my purpose to recommend dangerous postponement of that important duty. However, it is also true that the more desperate the situation, the more serious the matter of surgical intervention becomes. For that reason it is suggested that temporary measures be instituted for the few minutes required for the administration of the plasma, in order that the patient may have the benefit of trial of such a simple and harmless procedure, with the great possibility that the necessity for more formidable and dangerous intervention may be averted.

It would be a serious misunderstanding to think that concentrated human plasma is expected to contribute to the cure of the actual infection itself in acute laryngotracheobronchitis, for such is not the case. That important object will be accomplished, if at all, by the use of human immune convalescent serum, as already described, or by the natural resistance of the patient. However, if treatment with

convalescent serum is begun too late to give it an opportunity to take effect in time to avoid the development of laryngeal obstruction, or if the patient is presented with such definite obstruction as to demand immediate respiratory relief, then it is necessary to establish promptly an adequate and usable airway. That this can often be accomplished by the use of four times concentrated plasma has now been demonstrated, and the method is worth a trial in every appropriate case.

Venesection. It is quite certain that blood volume is definitely increased by intravenous serum administration, and more especially by hypertonic plasma injections. Therefore, if hypertonic plasma is to be given, particularly after recent convalescent serum administrations, or in the presence of the suspected pulmonary stasis or evident circulatory embarrassment which are sometimes present in these cases, it seems only reasonable to precede the injection by modest blood letting. This should amount to about four times the quantity of concentrated plasma to be administered. In fact, it seems logical that in many cases of this type the therapeutic action of the plasma might be increased by a preliminary reduction of blood volume and there is no contraindication to that procedure.

Other Measures. Many other measures have been recommended, some of them very meritorious, by those writers to whom reference has already been made, and by others. Galloway[22], for example, makes an excellent case for postural drainage plus rest, fluids by mouth and parenterally, oxygen and atmospheric moisture. Davison[23] also stresses most of these factors, with especial emphasis on atmospheric temperature and humidification. Every one of these suggestions has its value and some are indispensable.

Possibly one other form of treatment should be mentioned—that of foreign protein administration. Experience leads me to conclude that unquestionably when more specific forms of treatment are not available large doses of foreign protein, usually administered in the form of a mixed bacterial vaccine, are of value. While not in any sense specific, the general reaction from administration of foreign protein seems to hasten resolution and to shorten the period of obstructive edema. Results of this treatment are not conclusive enough to facilitate exact evaluation, but I am definitely persuaded from clinical observation that it has merit. However, now that immune human serums are more freely available, I no longer resort to this less scientific and more severe method of treatment, because there seems to be nothing additional to be gained by it.

RESULTS

In my own experience the results of these methods of nonsurgical treatment are most encouraging. The use of humidified, cooled oxygen certainly gives immediate respiratory relief and often affords ample time for the readying of other measures and even, at times, for their therapeutic effects to become apparent.

Administration of immune human serums is most assuredly well enough established to justify its use. The results, of course, are not immediately spectacular but should be quite apparent in the second 24-hour period after administration. Then the improvement is often very encouraging, whether or not other more immediate measures have been required in the meantime.

Concentrated human plasma is, of course, only valuable for the reduction of obstructive edema, but for that purpose its use is strongly recommended. I have seen little patients showing the typical pale cyanosis of partial asphyxia with exhaustion respond in a very gratifying manner. Stridor disappears, respirations quiet down, cyanosis rapidly fades, and the patient falls asleep. This all occurs within a matter of minutes after the administration of the plasma is completed. Then the entire clinical picture usually continues to improve, especially if sufficient quantities of immune serum have also been administered, and the patient soon has remaining only a simple, nonobstructive tracheobronchitis and laryngitis from which recovery is rapid.

The severity of infections varies, of course, in different epidemics. and that is certainly true of acute laryngotracheobronchitis. For example, in certain years it seems that almost every case suffers from severe complications, such as pneumonia, destructive lesions of the mucous membranes in the trachea and bronchi, or septicemia. These complications can also occur in certain individual cases in any year, but whenever they happen they are sure to be very disastrous. The recommended methods of treatment may prove to be of little avail in some of these cases, but they should not be permitted to confuse the more typical picture which is here under discussion.

It may seem that abstraction of fluid from the tissues by intravenous use of hypertonic plasma might result in an intensification of the tendency toward dryness, with increased viscosity and stickiness of the secretions and more rapid plug formation. While this seems logical, as a matter of practical fact it simply does not happen. The

injection of convalescent serum and of hypertonic plasma does not dry the membranes, but does seem to help to normalize the secretions. In fact, there are no observed ill effects from serum or plasma administrations, with the exception of the very rare mild chill and pyrexia which are known to follow similar intravenous injections. In an extensive experience with human convalescent serum I have never found reactions to exceed one per cent, and since they cause only slight and very temporary inconvenience, it is not necessary to attempt to guard against them by means of skin tests, as suggested by Levine and State[24, 25], in such desperate cases as these.

Finally, I wish again to emphasize that this paper is in no sense an argument against the use of needed surgery in the treatment of acute laryngotracheobronchitis. Only within the limits of good judgment should nonsurgical methods be attempted. If they fail, as they inevitably will in a certain proportion of cases, then surgical intervention should be resorted to without delay. It should be further stated that the methods herein recommended are, in their proper places, also effective and valuable as adjuncts to surgical treatment. Their benefit should therefore not to be denied individuals who are receiving such treatment.

CONCLUSIONS

1. A very serious disease of children, acute laryngotracheobronchitis, with a high mortality rate, can now in many cases be successfully treated without surgical intervention.

2. Convalescent human serums best combat the infection in the respiratory mucous membranes.

3. Humidified oxygen is exceedingly valuable for relief of respiratory distress and to give the necessary respite while other measures are in preparation or taking effect.

4. Surgical intervention, especially tracheotomy, for the relief of dyspnea, frequently has serious consequences, predisposes to lower respiratory difficulties, and is to be avoided if prompt and adequate relief can be obtained without it.

5. Intravenous administration of hypertonic human plasma will often promptly reduce the subglottic edema to the point of comfort and safety.

510 Republic Building.

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LII

ACUTE THYROIDITIS IN RELATION TO DEEP INFECTIONS OF THE NECK

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In reading the available literature covering acute inflammation of the thyroid gland, one is impressed by the general agreement that it is a relatively rare condition. One of the earliest references is cited by Cochrane and Nowak[1], who found that Bouchet in 1857 had reported five cases in a "monograph which remains to the present day a classic for its accuracy and thoroughness of description."

At a time when bacteriology was wholly in an experimental stage, Kocher is quoted by Crotti[2] as having stated that every acute thyroiditis must be due to metastasis of an infection somewhere in the body. This opinion was confirmed by Tavel[3] in 1892.

Mygind[4] in 1894 differentiated between an acute inflammation occurring in a normal gland and one occurring in a previously adenomatous gland. The former was designated acute thyroiditis, and the latter was termed strumitis. Each was considered a distinct clinical entity. Mygind further stated that acute thyroiditis was pathologically an acute cellulitis and remained so until the inflammation subsided. Strumitis, however, progressed to suppuration. As a result of the teaching of Ewald, in 1896 the distinction between acute thyroiditis and strumitis was abandoned. Since that time both have been regarded as acute infections, many of which subsided without ever becoming purulent, whether they occurred in normal or adenomatous glands.

With the exception of occasional case reports at long intervals which seemed to attract no particular attention, the subject was not again studied until 1911 when Robertson[4] reported 3 cases of his own and collected 93 others from the literature. Ten years later Hagenbuch[5] reported 43 cases from 46,000 admissions to the Basle Clinic during the period from 1911 to 1921. Clute and Smith[6] reported from the Lahey Clinic in 1927 that drainage of a thyroid abscess following acute inflammation had been done only three times in a series of 3,000 operations on the thyroid gland. In 1928 Burhans[7] reported

a case of his own and found that more than 200 cases were on record. Joll[8], in 1931, reported two cases in a series of 2,000 goitre patients admitted to a London hospital. Crile and others[9], in reporting 10,000 thyroid operations, noted suppuration 74 times. Cochrane and Nowak[1], in 1934, reported 7 cases of abscess in a series of 500 thyroidectomies and 3 cases of acute thyroiditis which did not progress to suppuration.

The thyroid gland is unique in its anatomical relationships. It is superficially located, protected only by the thin platysma, sternohyoid and sternothyroid muscles. It is thus highly vulnerable to accidental injuries. It is, however, well protected against the spread of infections by a firm capsule and is enclosed within split fascial planes. The lymph and blood vessels are highly anastomotic. The supply of both these fluids is greater per gram weight than for that of any other organ of the body.[10] Normally it has no duct along which infections may progress. Cleland[11] and Stein[14] have each reported a case of thyroiditis resulting from a persistent thyroglossal duct. Except in instances of infection resulting from direct trauma, as reported by Meeker[13] and Link[12], the blood and lymph channels are the only portals for the entrance of infection.

Acute thyroiditis occurs in females about twice as frequently as in males. The age incidence has varied between the extremes of 18 months and 77 years, but the greatest number has occurred between 20 and 40 years. The thyroid gland was previously normal in only 26 per cent of cases. The mode of transmission is most commonly by metastasis from a systemic infection through the blood stream. It is doubtful if an infection can progress to the thyroid gland against the lymph stream and through protective lymph nodes. Localized infections, particularly of the upper respiratory tract, are actually general systemic infections which menace the blood stream, just as any other infection which is less confined as to symptoms and physical findings.

The immediate exciting cause of the disease is given in Table 1, which is made up from analysis of 136 cases reported by Burhans[7], Robertson[4], and Hagenbuch[5].

An additional 24 cases collected by the author from the literature since Burhan's report are analyzed in Table 2.

The most constant symptom is pain over the gland, which is present even in the mildest form of the disease. Additional symptoms develop with increase of tension within the capsule and any movements of the muscles of the neck which displace the gland.

TABLE 1.—IMMEDIATE CAUSE OF THYROIDITIS IN 136 CASES

	BURHANS	ROBERTSON	HAGENBUCH
Arthritis, Suppurative	2		
Diphtheria		4	
Enteric Fever		6	
Empyema	1		
Erysipelas	3	4	
Influenza	8	4	11
Meningitis			
Malaria		4	
Mastoiditis	1		
Pneumonia	9	6	9
Pharyngitis and Tonsillitis	14	3	
Puerperal Fever	13	4	
Rheumatic Fever		7	
Typhoid Fever	5		
Tooth Extraction			1
Vincent's Angina			6
Glossitis	1		

Cough results from enlargement of the gland, which creates reflex irritation in the larynx. The patient will resist cough when lying in the dorsal position and struggle to sit up in bed. The sitting position lessens the pressure within the capsule and reduces displacement of the gland when coughing. Burhans[7] cites three cases in which the contents of thyroid abscesses ruptured into the larynx and were expectorated. Dysphagia may be so severe that the patient refuses food. The pain may be referred to the ear. Cochrane and Nowak[1] state that pain in the ear may be the most prominent symptom. These authors also call attention to hoarseness and aphonia as symptoms, which may completely mask the underlying condition. Severe infections, especially those which progress to abscess formation, may begin with chills, followed by high fever and a toxemia which is overwhelming. Hoarseness is a common symptom which Theisen[29] states is due to venous congestion and edema without paralysis.

Some increase in the size of the gland is always present. One lobe or the whole gland may be involved. This swelling may conform to the outline of gland, or with edema of the overlying structures it may completely occupy an area extending from the hyoid to the sternum.

The patient prefers to sit upright in bed with the head slightly flexed, thus relaxing the subhyoid muscles. The cervical spine is held fixed in this position. Lateral movement of the head is accomplished

TABLE 2.—CAUSE OF THYROIDITIS IN 24 CASES

	Pneumonia	Puerperal Sepsis	Urinary Tract	Malaria	Prostatectomy	Pharyngitis	Influenza	Otitis Media	Tonsillitis	Alveolar Abscess	Mastoiditis	Carcinoma	Bronchitis
Coope & Findlay[15]	1												
Thorburn[16]										1			
Pic, Dolore, & Panfigue[17]			1										
Salleras and Colodrero[18]	1												
Eberts, Fitzgerald, & Silver[19]	1												
Lanzani[20]		1											
Wahrsinger[21]		1											
Sein[22]				1									
Porter[23]					1								
Mora[24]						2							
Clute[25]							1						
Weinstein[26]													
Cochrane & Nowak[1]	3			1			2	1	1		1		
Norland[27]												1	1
Greenfield & Curtis[28]						1							

by rotation of the thorax. Salivary secretion is stimulated, but swallowing is resisted; and saliva flows from the mouth.

Venous congestion and edema induce dyspnea in about 50 per cent of the cases which progress to abscess. In Burhan's series, choking occurred seven times. Two patients were subjected to tracheotomy and subsequent incision and drainage, three required incision and drainage, and in two, relief was gained by spontaneous rupture.

As in pharyngomaxillary abscess, fluctuation is obscured by the fascial covering of the gland and the hard swelling of the overlying tissue.

The clinical picture of acute thyroiditis resembles cellulitis of the neck more than any other condition. However, the usual location for the latter is in the submaxillary region; and as pointed out by Cochrane and Nowak[1], any cellulitis with maximum tenderness located in the midline low in the neck indicates abscess formation in the thyroid gland. Ludwig's angina may be confused with suppuration of the thyroid, especially when it crosses the midline under the tongue. The history of infection following trauma or pain and swelling beginning in the floor of the mouth, with a cellulitis located under the chin, provides the differential diagnosis.

Perichondritis of the laryngeal cartilages is another condition which must be considered in diagnosis. Palpation of the cartilages will reveal a swelling of the perichondrium which obscures the sharp outline of their edges in this condition. Furthermore, there is no enlargement of the thyroid gland in perichondritis. The laryngoscopic picture will give conclusive evidence as there is no circumscribed bulging or other evidence of abscess, nor is there any fixation of the arytenoids.

Very early in the course of this disease one can appraise the virulence of the infection. A mild thyroiditis may cause little discomfort or constitutional reaction. The patient may continue to carry on his daily routine. The more severe infections, which terminate in suppuration, may be ushered in by chills, fever, and leukocytosis. In the nonsuppurative cases the clinical course lasts one or two weeks. The swelling of the gland continues to increase moderately during the first few days and then diminishes rapidly, so that by the sixth or seventh day all signs and symptoms may have completely disappeared. The prognosis in simple thyroiditis is good. Under complete rest, sedation, and supportive treatment the inflammation will generally subside within ten to fourteen days. When suppuration occurs, the outlook is favorable if the condition is recognized early and prompt evacuation of the abscess and drainage instituted. Only by this procedure can such serious complications as laryngeal or esophageal fistula and mediastinitis be prevented.

Sulfonamide therapy is indicated, particularly in thyroiditis following infections of known bacterial origin. The hemolytic streptococci and pneumococci have been more frequently cultured than any other organisms. However, a large number of cases have followed respiratory infections caused by viruses which are not influenced by this group of drugs.

REPORT OF CASES

CASE 1. Mr. R. I. was seen October 10, 1932. His chief complaint was pain in the right side of the pharynx and the right ear which increased on swallowing and coughing. These symptoms had been present two days and were increasing in severity. There was a history of influenza ten days previously which had confined him to bed for only three days, after which he returned to his work.

The head was held in a slightly flexed position and tilted a little to the right. The shirt collar was worn unbuttoned because of a painful spot over the right lobe of the thyroid. Palpation revealed a slight generalized swelling over this area with a point of greatest tenderness close to the sternomastoid muscle. Examination of

the ears, pharynx, and larynx showed no changes in color or thickness of the membranes. The temperature was 99.2°F. pulse, 84. Treatment consisted of rest, cold applications, and sedation. At the expiration of one week, all pain and swelling had subsided.

CASE 2. D. S., aged six years, was first seen in consultation September 15, 1936, in Mercy Hospital. Three weeks previously during influenza he developed pain in the left ear, followed by a profuse discharge of blood-stained purulent exudate. Four days later there was pain in the right ear, followed by similar discharge. The respiratory symptoms had subsided. A profuse discharge of thick yellow pus continued to drain from both ears. Since September 10 there had been a temperature fluctuation from 97°F. to 105°F., occurring twice during each 24-hour period; each rise of temperature was followed by a chill. The white blood count was 32,000, with 87 per cent neutrophiles, the hemoglobin, 47 per cent. Multiple metastatic abscesses were forming over the ulna and the scapula, and one over the fibula was draining. X-ray films showed dissolution of the mastoid cells and osteomyelitis of the fibula.

Bilateral mastoidectomy was performed September 15. The left lateral sinus contained an infected thrombus. The sinus was obliterated by packing after removal of the thrombus. A perisinal abscess was uncovered on the right side. The sinus wall was covered with granulations which were not disturbed. No ligation was performed on the left side. The operation on the right side was carried out hurriedly after the anesthetist had stated that the patient could not tolerate any further procedure. The patient left the hospital on October 13, the twenty-eighth postoperative day. The temperature had been below 100°F. for four days, the white blood count was 12,000, and the hemoglobin, 82 per cent.

On October 19 the temperature rose to 101°F. Dysphagia and hoarseness developed, and a marked swelling of the thyroid appeared. The pharyngeal mucosa was injected. The child preferred to sit upright in bed with the head slightly flexed. The temperature gradually rose to 103°F. on October 23. The thyroid swelling increased in size, and a brawny edema extended over the sides of the neck. The condition was very serious again. Hoarseness and dysphagia had increased. The swelling over the thyroid almost obliterated the sternal notch. Some difficulty in breathing developed, which indicated pressure on the trachea.

The patient was taken to the hospital for exploration of the neck. A collar incision was made and the gland exposed at a depth of about one inch. The capsule was very tense, and small areas of subcapsular hemorrhage were present. A series of needle punctures revealed an abscess in the right lobe close to the midline from which 3 cc. of blood-stained pus were aspirated. This portion of the gland was incised down to the abscess cavity and a rubber tube drain sutured in place. No growth was obtained from culture. There followed an uninterrupted convalesence. The dysphagia persisted for two days, but the pain in the ear and pharynx was relieved immediately. Drainage from the cavity continued for ten days. On November 3 the wound was healed and the patient discharged.

Suppurative thyroiditis may be followed by a general infiltration of connective tissue throughout the gland, inducing myxedema. Greenfield and Curtis[28] report their studies of the metabolism and

blood iodine content following recovery from this condition. They found that myxedema developed and was corrected by thyroid administration.

CASE 3. V. W., aged 19, was seen May 20, 1943. There was a history of pharyngitis lasting from May 2 to May 6. Since then she had apparently been well and had resumed her occupation. The chief complaint was sore throat, discomfort on swallowing, and fullness of the left ear. The nasal sinuses, pharynx, and larynx were examined, and no evidence of inflammation found. The tonsils had been well removed five years previously. The ears appeared normal, and the eustachian tubes were not obstructed. Her temperature was 99.4°F. and her pulse, 87. A slight fullness of the thyroid gland was present, and in the left lobe an area of infiltration and tenderness of about 3 cm. could be defined. Sulfanilamide therapy and bed rest were prescribed. In 72 hours the swelling of the gland was reduced almost to normal. The area of infiltration was much softer and less tender. On the sixth day medication was discontinued and the patient discharged.

CONCLUSION

Although acute thyroiditis is regarded as a rather rare condition, I believe it is more prevalent than is generally recognized. In a very mild form, such as Case 3, it may completely elude diagnosis and a spontaneous recovery ensue. Case 2 represents the most virulent form of the disease, in which diagnosis is more easily made. In such cases abscess of the thyroid is almost certain, and early surgical drainage is the only procedure which will avoid disaster.

Acute thyroiditis is the underlying cause of some common symptoms encountered in otolaryngology. Palpation of the thyroid gland as a routine procedure will, on occasions, richly reward those who practice it.

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LIII

A SUPPLEMENTARY REPORT ON EXTRALARYNGEAL ARYTENOIDECTOMY AS A RELIEF FOR BILATERAL ABDUCTOR MUSCULAR PARALYSIS OF THE LARYNX

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In October, 1940, I read a paper before the Annual Meeting of the Academy of Ophthalmology and Otolaryngology at Cleveland, Ohio, in which I gave the results of two cases of bilateral paralysis of the abductor muscles of the larynx, both patients having been operated upon by a technique which we called extralaryngeal arytenoidectomy. It was called extralaryngeal because the technique was to remove the arytenoid cartilage without causing injury to the laryngeal mucous membrane and thus avoiding the formation of cicatricial tissue within the larynx. This procedure was the result of the study of the literature on the subject of injuries to the recurrent nerve, and the conclusion was that the only operative procedures which gave relief in these cases were those which had something to do with the arytenoid cartilage. We found that anastomosis of the recurrent nerves had been a failure, not because the men who did the work were not the most competent, but because the impulses transmitted through the healed nerves caused spasms and not coordination of the laryngeal muscles. Ventriculocordectomy and cordectomy were a failure because of the resulting scar tissue.

The first case that I could find in this country in which the arytenoid cartilage was attacked in the surgical treatment of bilateral paralysis of the abductor muscles of the larynx, was a case reported by Baker[1], in 1916. In this instance he removed the right cord and the right arytenoid cartilage through a laryngofissure with a good end result. In my opinion, this doctor deserves credit for calling our attention to the importance of the arytenoid cartilage in all successful

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operative techniques for the relief of bilateral paralysis of the abductor muscles of the larynx. He was many years in advance of any of the later successful techniques using laryngofissure as the method of approach.

Twenty-three years after Baker's report, men began to think of attacking the arytenoid cartilage by the extralaryngeal route. In March, 1939, King[2] came forward with an extralaryngeal technique in which he utilized the principle of substituting a viable muscle for a paralyzed one and in this particular instance attached the anterior belly of the omohyoid muscle to the muscular process of the arytenoid cartilage and reported some successful cases. The procedure appealed to every laryngologist confronted with a case of paralysis of the abductor muscles. A number of operations were performed by enthusiastic laryngologists, but reports of successes were few and confusing. Such was the position of the King operation in 1939, when I was trying to find some safe method for use in the cases of abductor paralysis on my service. The King operation in my opinion was a step in the right direction. First, it was extralaryngeal, thus avoiding the formation of scar tissue; second, it preserved the tissue of the larynx, hence, increasing the chances of the patient's having a good voice; third, it was directed toward the arytenoid cartilage, which I felt was the keystone of all successful operations. Since his first report, King[3] has changed his technique and now completely mobilizes the arytenoid cartilage and transposes it to the side of the larynx.

Because of the confused state of the reports at this time, I decided to develop a technique of my own for extracting the arytenoid cartilage and I wanted it to be an extralaryngeal operation. I felt that if I could do this the result would be good because:

1. It would destroy the tension of the cord on the side from which the arytenoid cartilage was removed and allow it to fall away from the midline of the larynx.

2. The space created by the loss of the arytenoid cartilage would be obliterated by nature and this would further increase the area between the cords posteriorly.

3. The position of the anterior third of the cords would be slightly altered and thus the chances of the patient's having a useful voice would be good.

These conditions have come to pass in all those patients whom we have decannulated. In some, there has been more contraction of the posterior end of the cord than in others. In some, the cord on the

operated side has fallen further out of alignment with the unoperated cord than would be expected. But in all, the anterior third of the cord has remained in such a position that these patients have what I think to be a good speaking voice. I might say here that I have not had the opportunity of seeing a patient who was operated upon by some other method, so I realize that my conclusions may be very personal; however, I do not intend them to be such. This I can say, that any of the patients, upon whom I have operated and who have remained under my care and have been decannulated, have improved to the extent that they are better satisfied with themselves from a social and economic standpoint than they were before the operation; they do not want their tracheotomy tube back, though they may show some distress on unusual exertion. We have been successful in many instances and we have had some failures, and I hope that we have learned by our failures.

When we first started to do the operation, we felt that general anesthesia was the anesthesia of choice. Then we used local anesthesia, so that at present it is a matter of choice with the patient and the doctor. However, I believe that all patients having local anesthesia should have some pre-operative medication. In the beginning we used a feeding tube but found later it was unnecessary, for when a patient is operated upon under local anesthesia, he may be given fluids as soon as he is returned to bed.

We felt that the intratracheal tube was essential and helped us fix the arytenoid cartilage in the beginning. Now, we do not use the intratracheal tube because we find that we are more likely to do damage to the laryngeal mucous membrane. It forms a hard surface and when a sharp scissors for freeing the arytenoid is used, it is very easy to lacerate the laryngeal mucosa. In the first few cases, we did not give much thought to sewing the mucous membrane of the larynx after it had been injured; now we are very careful to do so and also to put some fine catgut sutures through the frayed fibers of the arytenoid muscles.

At the start, we did not think it necessary to fix the cord away from the median line of the larynx, believing that the formation of scar tissue was sufficient to retract the cord and give us a good airway. At present we make this an important part of the operation and call upon the bronchoscopist to help us place a suture below the cord in such a manner that it will give us 10-12 mm. of space between the cords at the time of operation.

In the original technique, not much thought was given to the thyrohyoid muscle; it was cut and sometimes it was sewed back into position and sometimes it wasn't. Now I believe that it is very important to replace this muscle, for it is one of the elevators of the larynx and elevation of the larynx helps these patients breathe. It also keeps the larynx from sagging on one side and aids the mucosa of the larynx to heal properly.

In the early cases, we encouraged our patient to talk after the operation. I felt that use of the voice would stimulate healing. We now feel that the more rest the patient gives the larynx immediately after the operation, the better the result. The rest, we believe, allows the muscle fibers to retract and reduces the amount of edema. We used to be delighted when we could decannulate these cases within three weeks, but now we have changed and, if they are happy in the fact that they can breathe through their larynx with the tube corked and will cooperate by wearing their tube longer than three weeks, we let it remain for six weeks. We have found that the younger and healthier the patient, the greater his chance for an excellent result.

Also, we found that some patients develop more and heavier scar tissue than others. Older people and cardionephritics develop considerable edema about the area from which the arytenoid cartilage has been removed and in some cases it may take considerable time for this to subside. One patient on whom I operated in August, 1942, with Edward Wright still has some edema in this area. Although she wears her tube corked all day, she still is frightened about being decannulated. If the patient has had a terrifying experience prior to his tracheotomy, it takes him a long time to forget it.

The postoperative observations which we have made on the larynges of these patients have been interesting. In some of them it looked as though the unoperated cord moved when attempts at adduction were made. This may be the case if the unoperated arytenoid cartilage is not ankylosed. The arytenoid prominences remain after the cartilage has been removed, but the prominences are definitely separated. We know from the investigations made by Ziegelman[4] and others that the interarytenoid muscles receive some branches of the superior laryngeal nerve and that there is an association of this nerve with the ascending branch of the recurrent nerve. It is logical to believe that with nothing to oppose it but soft tissues the remaining arytenoid cartilage could have a lateral movement to the operated side in the event of coordination between the inferior constrictor muscle of the pharynx and the remaining fibers of the interarytenoid muscle.

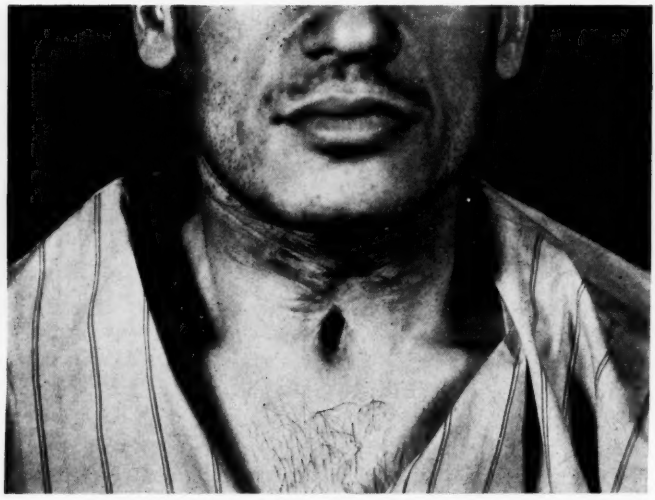

Fig. 1.—Mark shows upper limit of loss of tracheal rings in the case of of I. G., before operation removing right half of the thyroid cartilage and the arytenoid cartilage.

I saw a most unusual case with Dr. V. K. Hart, of Charlotte, N. C., in April, 1942. A negro girl of about 18 had had a thyroid operation about two years before, with a resulting double abductor paralysis. Doctor Hart had done a double external arytenoidectomy on this girl and, when I saw her, she had a good voice and an ample airway. The arytenoid prominences were very definite and well separated. When this patient made an effort at adduction the arytenoid prominences made a sliding lateral movement and the two cords would be brought together. Dr. Hart was not sure he got the arytenoid cartilage on the left side, but was sure he had been successful on the right side. We both were encouraged and thought this case a success. You can imagine my disappointment and chagrin when he wrote me on Nov. 17, 1942, and told me that it was necessary to do a secondary tracheotomy on this patient because the cords were becoming fixed in the midline again and the beautiful lateral sliding motion had disappeared.

In some of the first patients on whom we operated, we found that after they had been decannulated six or eight months the operated cord became flaccid and flabby and would move up and down with

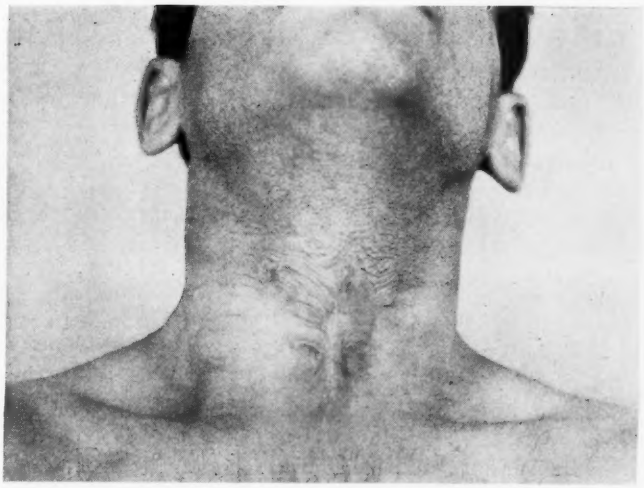

Fig. 2.—Closure of I. G., using the pretracheal muscles and scar tissue as the anterior wall for the trachea.

inspiration and expiration and would sometimes make a sound when the patient took a deep forced breath. I think that I can correct this by the use of different suture material and by making the patient rest his voice postoperatively. In the majority of cases, however, the cords have assumed the desired appearance with the posterior end of the operated cord pulled over to the side of the larynx and the anterior third remaining in contact and giving ample airway and a good speaking voice.

The case which I think is the most interesting is that of a young man, Isador G., who had a laryngeal obstruction with fixation of both arytenoid cartilages. This patient had been in the hospital some 76 times in the course of three years. He had considerable hypertrophy of the mucous membranes of his larynx and thickening of his thyroid and arytenoid cartilages. It was thought that removal of one or both arytenoids might increase his airway. He was prepared for an arytenoidectomy and at the time of operation it was found that he had an old perichondritis causing the obstruction. One arytenoid was removed, but on laryngoscopic examination the amount of space gained was negligible. I then decided to remove all the cartilage from one side of his larynx and sew the internal perichondrium and the thyrohyoid muscle to the median surface of the pretracheal muscles, hoping that the formation of scar tissue and the fixation of this side of the larynx to the under surface of the muscles mentioned would widen the larynx laterally. The result was most

encouraging and later Dr. Daniel S. Cunning removed some hypertrophied tissue from his larynx. Two months following the operation he had sufficient airway to allow us to close a tracheal fistula which had existed since he was two years old—the result of necrosis of the tracheal rings following a diphtheria infection complicated by a tracheotomy. He is now employed in our hospital as an orderly.

TECHNIQUE OF THE OPERATION

The technique of the arytenoidectomy as performed at the present time is as follows:

A horizontal incision is made near the lower border of the thyroid cartilage, extending from the median line of the neck to the anterior border of the sternocleidomastoid muscle. The skin, the platysma myoides muscle and the pretracheal fascia are cut and the pretracheal muscles exposed. The sternothyroid, sternohyoid and superior belly of the omohyoid muscles are separated, clamped, and cut after the method of a thyroidectomy. This exposes the thyrohyoid muscle and the wing of the thyroid cartilage. The thyrohyoid muscle is cut and elevated, and a window is made in the lower posterior third of the thyroid cartilage below the level of the thyroid notch, with its anterior border limited by a line separating the middle and posterior inferior thirds of the cartilage. The window is made by cutting with a sharp-pointed knife through the external perichondrium and the thyroid cartilage, and the cartilage is removed with a curette or a small flat-nosed rongeur. The size of the window varies with the size of the larynx. A large larynx usually has a large arytenoid cartilage and a small larynx, a small arytenoid cartilage. However, a window $\frac{3}{8}$ in. square is sufficient and not too large for the ordinary case.

The removal of the cartilage brings into view the internal perichondrium of the thyroid cartilage, which overlies the musculature covering the arytenoid cartilage, together with a small branch of the superior thyroid artery and some small viens. This perichondrium is incised with a sharp knife or small scissors and removed. The small branch of the superior thyroid artery is located at about the middle of the upper border of the window. This may be clamped with a small mosquito forceps, but pressure and the application of adrenalin usually suffice. By careful dissection with a pair of sharp-pointed, medium-sized scissors through the fibers of the thyro-arytenoideus and the crico-arytenoideus lateralis muscles, the arytenoid cartilage and the crico-arytenoid articulation are exposed. The capsule of this articulation is severed with the scissors and the arytenoid cartilage tumbled from its articulation. With the aid of hooks, the arytenoid

cartilage is lifted and freed of its remaining attachments by careful scissor dissection. The mucous membrane covering the vocal process of the arytenoid is usually the most adherent and the last tissue to be separated. This area represents the posterior limit of the cord which may be identified by a white line above the muscle tissue. It is at this point that a suture of chromic catgut No. 0 is placed with a fine ophthalmic needle, and with the aid of the bronchoscopist the cord is pulled away from the median line of the larynx and the suture placed through the external perichondrium.

Another suture may be placed through the mucous membrane and the muscle tissue just below the cord and fastened through the fibers of the thyrohyoid muscle after it has been replaced. The pretracheal muscles are sutured together with chromic catgut No. 1 or No. 2, using mattress sutures. The platysma myoides muscle and the skin may be brought together with interrupted sutures of silk or Deknatal, or the platysma and the pretracheal fascia may be closed together with chromic gut and clips used on the skin. It is good surgery to place a cigarette drain under the pretracheal muscles and leave it in place about five days.

The operation may be performed on either side of the larynx. It is best to operate on the side on which the cord is most fixed. If both cords are equally immobile, the right side is selected.

General or local anesthesia may be used. If local anesthesia is selected, the usual pre-operative medication is given. The amount and strength of the novocain solution used may be varied with the experience of the operator. Part of the novocain solution used may contain some adrenalin to help control superficial bleeding. Deep injections must be made about the side of the larynx and the hypopharyngeal space as in a laryngectomy.

General anesthesia is given through the tracheotomy tube. If the patient is not wearing a tracheotomy tube, a tracheotomy should be performed under local anesthesia before starting the general anesthesia. The operative field is separated from the field of anesthesia by a sterile sheet dewed or clamped to the skin of the neck below the line of incision. In cases in which general anesthesia is given, an intratracheal tube (Flagg) may be used to fix the arytenoid cartilage, but this is not necessary and, if it is used, more care must be exercised to prevent injury and rupture of the intralaryngeal mucous membrane.

The patients are not decannulated until they can keep the tracheotomy tube corked day and night for three or four days and perform ordinary exertions without discomfort.

CONCLUSIONS

In conclusion, I do not hold that this operation is the best or the only operation for the relief of bilateral paralysis of the abductor muscles of the larynx. We have had 28 patients up to the present time operated upon by various operators with 23 decannulations; nevertheless I believe that other men will improve on the technique or devise new procedures which may be better. I think that a surgeon should do the operation which he does best and with which he has achieved his greatest success. I have tried to give you a complete report on this work of mine as it shapes up to date. It is for your judgment to dictate whether it is worthy of your adoption.

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LIV

SOME ASPECTS OF EMERGENCY PLASTIC SURGERY IN WAR INJURIES OF THE FACE

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The plastic surgeon, assisted by a dental surgeon experienced in maxillofacial prosthesis, is best qualified to treat facial injuries. In the peripetias of modern warfare, casualties occur in the sudden bombing of a city or aboard a warship at sea. Any physician or surgeon may find himself solely responsible to give first aid surgical assistance to patients with injuries of the face.

Certain aspects of war injuries of the face common in the present war are here described. These aspects include:

1. The management of war injuries to the soft parts of the face.

2. General principles of treatment of compound war wounds of the face.

3. Considerations on fractures of the facial bones involving the fronto-ethmoidal region with cerebrospinal rhinorrhea.

4. Management of comminuted fractures of the malar bone with ptosis of the eyeball.

WAR INJURIES TO THE SOFT PARTS OF THE FACE

Lacerations and Small Wounds. Multiple facial lacerations and wounds are caused by missiles set in motion by the force of an explosion, by the blast of shells or bombs, such as stones and gravel, glass, pieces of brick and cement, plaster. These missiles constituted the most frequent cause of facial disfigurement in the civilian bombing casualties in England (Figs. 1, 2). Some patients presented literally hundreds of wounds. The skin of the face assumed a veritable "cribriform" appearance at times as a result of the innumerable small, punctured and lacerated wounds. These wounds are nearly always filled with dust and grit resulting from the broken-up building materials. This foreign material must be removed to avoid deep tattooed pigmentation of the scars (Fig. 3).

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Fig. 1 Fig. 2

Fig. 1.—Multiple facial wounds caused by secondary missiles projected by bomb explosion.

Fig. 2.—Same patient three months later following secondary excision and suture of scars.

"Explosive" Wounds. The explosive effect of small high velocity bomb splinters and bullets has been recently reviewed[1], following the work of Wilson[2], and Cranz and Becker[3]. The high speed missiles create wounds out of proportion with their size. It is suggested that the tissues are stretched as by an internal explosion because of the violent dispersal of particles by the projectile in its course. These wounds are jagged, irregular, contused. Often much tissue around the track of the bullet is pulped. When the projectile is a fragment of bomb casing and it penetrates the hollow bones of the face, the explosive effect is maximal and a great deal of tissue may be destroyed. (Fig. 4).

Avulsions. Whole flaps of skin may be violently detached by a high explosive blast. The effects of the blast may be such that in some patients observed in England an avulsion of the nose, lips or the whole cheek is seen. These destructive lesions are not often seen in living patients as the patient rarely recovers from the serious intracranial or pulmonary lesions. (Figs. 6, 7).

Fig. 3.—Multiple facial lacerations caused by bomb explosion. Note pigmentation of scars by dust and dirt.

Crushing and "Crash" Injuries. Both these injuries produce severe, and often comminuted, fractures of the facial bones. The soft tissues are markedly contused, crushed. Crushing is frequently caused by falling building materials of a bombed house. In "crash" injuries the patient is projected forward with varying force. The most severe injuries are seen in airplane crashes when serious disorganization of the bony structure of the face and the base of the skull may occur. The vehicles of the mechanized armies, tanks, automobiles, motorcycles and "Jeeps" are responsible for many cases of this kind of injury (Figs. 8, 9).

The bony protuberances of the face, the supra-orbital ridges, nasal bones, malar bones, and the protuberance of the chin, act as "bumpers" and receive the first impact. As a result the bones of the face may be markedly displaced and comminuted.

Burns of the Face. It can be justly said that burns constitute one of the most frequent and most serious problems of modern mechanized warfare. The face, unprotected by clothing, and the hands, frequently ungloved, are exposed. The protection afforded by clothing is quite remarkable; it is not infrequent to have clothes destroyed with no serious burn to the skin.

Fig. 4

Fig. 5

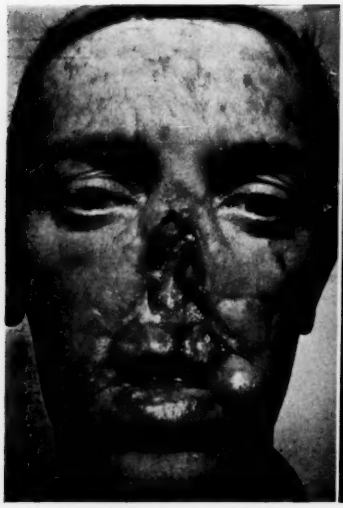

Fig. 6

Fig. 7

Fig. 4.—Explosive wound of face due to penetration by a bomb fragment.—(Courtesy of Sir Harold Gillies).

Fig. 5.—Shows mold of gutta-percha held on denture maintaining anatomical position of remaining tissues.—(Courtesy of Sir Harold Gillies).

Fig. 6.—Example of blast evulsion of upper lip and nose.

Fig. 7.—Profile view. View of same patient as shown in Fig. 6.

The constant use of gasoline in planes, in tanks, in motorized vehicles, exposes the soldier to the explosion of the fuel, either accidentally or in combat.

The "flash" of high explosives, producing a very intense heat, burns the individuals who are close enough but who escape death by blast or flying missiles. The incendiary bomb burns, but also frequently explodes, projecting flaming oil or phosphorus, thermite or other chemicals which may embed themselves in the skin and continue to burn, thus producing deep lesions.

On warships flaming oil may be projected on to the patients and continue to burn.

In the bombing of cities, victims may be trapped under the fallen debris of a house which is on fire, and not infrequently patients have been burned by the projection of coals from an open fire place.

GENERAL PRINCIPLES OF TREATMENT OF WAR INJURIES OF THE FACE

The aim of the surgeon treating any facial injury is twofold: The prevention and treatment of deformity and the restoration of function. It must be realized, however, that the face is different from the rest of the body—different because it is the medium of individual expression and identity, different also because of its remarkable resistance to infection. Perhaps because of a possible bacterial habituation but principally because of an abundant blood supply, facial wounds tolerate well contamination by saliva or nasal secretions. Compound wounds of the face are drained internally by the cavities, sinuses and pharynx. Because of the extraordinary blood supply, gas gangrene is never seen in the face and deep suppuration or cavernous sinus thrombosis is extremely rare, even in the most severe facial traumas.

Because of the favorable conditions debridement of the facial wounds can be sparing and not as radical as in wounds of the extremities. Fragments of fractured facial bones should be preserved unless they are completely detached.

The successful treatment of facial injuries requires the observance of three main principles:

1. The Avoidance of Wound Tension—Suturing a wound under tension not only will be followed by a frequent breaking-down of the wound due to tension ischemia by a hypertrophic scar, but the features of the face will be distorted. This disturbance of the normal

Fig. 8 Fig. 9

Fig. 8.—Aeroplane crash injury.

Fig. 9.—Same patient following primary wound suture.

contour of the region is much more conspicuous than the scar itself. Where wound closure cannot be accomplished without tension, local plastic flaps must be made to relieve tension or, if this is impossible, a primary skin graft should be done.

2. The Elimination of Raw Areas—This is accomplished by early wound suture or if a suture cannot be performed, by early skin grafting. When there is tissue destruction and penetration into a mucous membrane-lined cavity, the intervening raw areas are eliminated by suturing the mucous membrane to the skin.

3. Preservation of the Anatomical Position of the Tissues—Displaced tissues are replaced in their original position. It is particularly important that, when extensive tissue destruction has taken place, the tissues surrounding the defect be prevented from closing in to obliterate the defect of tissue (Fig. 5), as mentioned previously. Skin edges are sutured to mucous membrane edges. Also it is essential to fill the defect with a mold supported by an extension from a dental splint. Thus the surrounding cheek tissues are supported. The subsequent plastic repair is made easier than if a collapse of the

tissue takes place distorting the angle of the mouth, the base of the alae of the nose and the lower lid.

Immediate Suture of Wounds of the Face. It is essential that whenever possible facial wounds be sutured immediately. The best results are obtained where surgery is done as soon as possible after the accident. (Figs. 8, 9). Plastic surgery is much easier at the early stage than it is months later. Wound suture must be preceded by what we may call "surgical cleansing"; that is the removal of all foreign bodies and debridement.

Careful removal of all sand, earth and grit by washing with soap or even mild scrubbing, by picking out the larger pieces, is necessary to insure clean healing. Thus the pigmented scars which are so conspicuous, will be avoided. No antiseptics should be used as they tend to produce cellular fixation. If difficulty is experienced in ridding the wound of all foreign bodies the remainder should be excised.

Under the term wound debridement is designated a resection of the wound edges so as to remove all the crushed, contused, devitalized tissue before suture is performed. It must be emphasized, however, that this resection of tissue of the face should be very sparing because of the excellent blood supply; it should be just sufficient to create clean-cut wound edges.

Following these procedures, approximation can be done using fine instruments, fine needles, fine suture materials and a gentle touch, closing the wound plane by plane after careful hemostasis. A pressure dressing with an elastic bandage will prevent hematoma and edema. Stitch marks should be avoided by the use of the finest sutures and by their early removal. Permanent stitch marks are unnecessary and greatly complicate subsequent plastic repair.

It has been generally accepted that wound suture to be successful should be done during the first six to eight hours after the injury. Recent studies have shown that most wounds are contaminated from the start as evidenced by positive cultures. It is only later that the clinical infection starts as a result of the devitalization of the tissues.

Conditions brought about by warfare often render immediate suture impossible. In some cases of innumerable lacerations it is impossible to perform immediate suture. It is preferable to allow spontaneous healing to take place and later perform piecemeal scar excisions. In other cases sutures can only be done after the rush of seriously stricken cases. The advantage of closing the wound is such that an attempt should be made at delayed suture.

Fig. 10.—Delayed wound suture with drain.

Chemotherapy. The "Waiting Sulfonamide Dressing." This "waiting dressing" is an application of the bacteriostatic effect of the sulfonamides. The wound is packed with a vaseline gauze dressing containing a sulfonamide. Sulfanilamide is the most soluble and readily absorbed locally. It does not tend to cake.

It must be remembered that the other sulfonamides (sulfapyridine, sulfathiazole, sulfadiazine) being less soluble must be used in small quantities, lest they act in the wound as foreign material.

No figures are available as to what extent chemotherapy has lengthened the "safe period" for wound suture.

Technique of Delayed Wound Suture. Two techniques of delayed wound suture can be carried out:

1. Delayed Wound Suture Without Drainage. After surgical cleansing sulfanilamide is insufflated into the wound, penetrating into all recesses and crevices, and the wound is completely closed.

2. Delayed Wound Suture With Drainage. The same procedure as above is carried out but a strip of vaseline gauze thoroughly impregnated with a sulfonamide is laid into the wound. The wound edges are then sutured without tension by interrupted sutures over the gauze. The ends of the gauze are left protruding through each end of the suture line for drainage. After 6 to 12 days the gauze is pulled out gently, progressively or at once, and wound healing completes itself (Fig. 10).

Treatment of War Burns of the Face. Many burns treated under war conditions have become infected. This has been particularly noticed in cases in which coagulation of the burned areas has been done with tannic acid. The reasons are simple: these cases were treated late, under poor conditions of treatment, often tanning was carried out over deep third degree burns.

The tanning principle of treatment can only be carried out when the burn has been seen early, when the area has been thoroughly cleansed with soap and water. Over deep burns the tan and the destroyed skin form a tenacious and stiff coagulum, slow to separate, an obstacle to the treatment of suppuration and to skin grafting.

The tanning agents (tannic acid, gentian violet, sulfadiazine and triethanolamine) are uncomfortable around the mouth where the tan tends to crack, dangerous around the eyelids where the stiff tan causes exposure of the eyeballs.

The treatment of third degree burns is based upon the early replacement of the destroyed skin by skin grafting. The tanning agents form an adherent coagulum which retards the skin grafting.

A sulfonamide ointment applied over the burned areas after cleansing of the areas appears to constitute the most practical form of treatment of facial burns. Soap and water remove the dirt; cetyl-trimethyl-ammonium-chloride is useful as a detergent. Trichlorethylene will efficiently dissolve oil which often covers burns occurring on warships.

The burned areas are carefully examined to determine the depth of the burn. Burns of the first degree are characterized by erythema; those of the second degree show blister formation. These blebs should be resected under aseptic precautions, taking care to leave no fringes. The crux of the treatment in the superficial burns is to prevent infection.

When, following the burn, the skin appears white, feels dry, parchment-like, when upon pressure the whole area moves as one mass and gives the sensation of a piece of cardboard buried under the skin, in all probability one is dealing with a third degree burn. The skin is destroyed. It must be replaced so as to avoid contractures and distortion of the features.

The ideal is to perform an immediate resection of the burned area followed by a skin graft. This is rarely feasible because it is difficult to tell at the start the exact extent of the burn. It is preferable to wait until around the tenth day, at which time the slough of

the destroyed skin limits itself. It is then resected and skin grafted, with a "split" skin graft. During the time interval between the burn and the skin grafting, the burned region is kept covered with sulfonamide ointment.

One frequently finds a mixed second and third degree area; small regions in which the full thickness of the skin has been destroyed alternate with others in which the destruction is more superficial. They are more frequent around the eyelids, because of the added heat caused by the burning of the eyelashes, and also because of the thinness of the skin of the eyelids. Ectropion is quick to develop and should be corrected early by skin grafting.

When extensive loss of facial tissue takes place either by avulsion, extensive lacerations, or crushing, it is impossible to effect a primary wound suture. A skin covering must be provided immediately by means of skin grafting. After surgical cleansing an "intermediate" thickness skin graft is cut either with Blair's razor knife or with Padgett's dermatome. The skin graft is sutured into the defect and held in position with adequate pressure. In this manner rapid epithelial healing is obtained, infection is avoided, and particularly are prevented the contractions resulting from the deposit of fibrous tissue and collagen which occurs in all wounds remaining unepithelialized longer than five weeks[4]. This "skin dressing" may be only temporary but serves not only to lessen the subsequent deformity but also to advance the date at which a reconstructive plastic operation may be performed.

Sulfanilamide powder may be sprayed on to the wound before the application of the skin graft. The bacteriostasis thus obtained has permitted a high percentage of skin graft "takes" in infected wounds[4].

General Principles of Treatment of Compound War Wounds of the Face. During the war of 1914 to 1918 these compound wounds were frequent because in trench warfare the face is the most exposed part of the body. Although less frequent in the present war these lesions are seen, often due to projectiles through apertures of tanks or pill boxes. High velocity projectiles penetrating into the facial bones enter the mucous membrane-lined sinuses and produce a destructive "explosive" wound.

Emergency treatment of these wounds will consist in arrest of hemorrhage by ligature and gauze packing. Particularly in compound fractures of the lower jaw the tongue must be kept protracted

in order to avoid an obstruction of the airway. A practical way to accomplish this is by means of a safety pin. Following these first aid measures the patient can be transported.

Treatment must be completed and will follow three main principles:

1. Preservation of the anatomical position of the structures. The reduction of fractures will be carried out; reduction of nasal fractures; reduction of jaw fractures using wiring, elastics or splints. To bring forward a posteriorly impacted maxilla it is necessary to exert traction based on a plaster head cap. The treatment of comminuted compound fractures of the mandible with loss of teeth is made easier by the external pin fixation methods[5].

2. In wounds presenting marked tissue loss, support of the surrounding tissues by prosthetic appliances, as previously described.

3. Elimination of raw areas. Where tissue destruction is extensive, the skin edges are sutured to mucous membrane edges.

Whenever possible wounds are sutured following surgical cleansing. A question which often arises is: which procedure should precede the other, the suture of the soft tissue or the reduction of the bones? If wound suture is followed by extensive manipulations to reduce the fracture, the wound may be torn open. On the other hand if the wound suture is done second it is thoroughly contaminated by intra-oral maneuvers. It can be said that the order of procedure will vary according to the individual case, but as a rule the wound suture should be done first as it constitutes an emergency, whereas a fracture reduction can be done without much detriment at a later date.

CONSIDERATIONS ON FRACTURES OF THE FACIAL BONES INVOLVING THE FRONTO-ETHMOIDAL REGION WITH CEREBROSPINAL RHINORRHEA

Facial injuries producing cerebrospinal rhinorrhea are frequent in war time, either as a result of direct trauma by a projectile or as a result of "crash" of mechanized transport and of airplanes. Most frequent of these injuries are those involving the frontal sinuses and the nasolachrymo-ethmoidal region. Less frequent are the fractures of the maxilla with gross impaction into the ethmoid. This type of injury causes violent trauma of the type sustained in airplane crashes by projection of the face onto the instrument panel, a bomb sight or other protruding object in the plane.

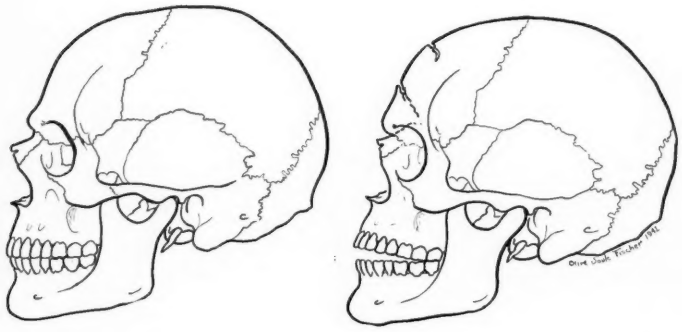

Fig. 11.—Drawing illustrating normal skull and skull after impaction of the fractured maxilla into the cribriform plate region.

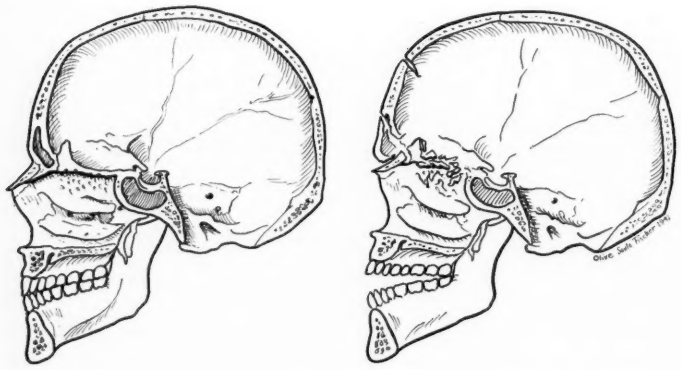

Fig. 12.—Drawing of sagittal section illustrating normal cribriform plate and comminution of the cribriform plate following impaction by fractured maxilla.

Depressed fractures of the frontal sinus involving the posterior wall may cause a tear in the dura, or a fracture line may extend inwards to the region of the cribriform plate.

In fractures of the nasolachrymo-ethmoid region, usually the result of a head-on crash, the nasal bones and the ascending processes of the maxillae are pushed back over the lachrymal bones and into the ethmoid labyrinth. Fracture lines may penetrate laterally into the roof of the ethmoid; or bone fragments, ethmoidal cell walls, may be pushed through this lamellar roof. Medially the cribriform plate may be involved by direct penetration of the fracture lines or by penetration of the perpendicular plate of the ethmoid.

In fractures of the maxilla in which the whole middle block of the face is pushed upwards and backwards, a cerebrospinal rhinorrhea is produced by the impaction and comminution of the ethmoid labyrinth (Figs. 11, 12). These fractures have been well described by Cairns[6]. The dura is torn by direct laceration by the fractured bones. In some cases bone fragments are pushed into the frontal lobe. The dura is extremely thin in the region of the cribriform plate and the roof of the ethmoid; it constitutes the inner periosteum of the bone. Tearing is facilitated by the dural prolongations along the olfactory nerves passing the cribriform orifices. This anchorage prevents any displacement; instead the dura is ruptured. Behind the frontal sinuses the dura is thicker and more resistant to injury.

MANAGEMENT OF FRACTURES OF THE FACIAL BONES WITH CEREBROSPINAL RHINORRHEA

In cases of severe maxillofacial or frontal injuries with cerebrospinal fluid leak there is a dual problem: (1.) the most important, that of dural tear and escape of the spinal fluid and the danger of meningitis. (2.) that of the facial injury. Patients presenting a spinal rhinorrhea first show an escape of blood, the fluid then becomes brownish in color, finally clear. Sneezing is frequent and there is a feeling of a postnasal discharge which has a salty taste. To confirm the diagnosis of spinal fluid the following tests can be done: anosmia; tests on spinal fluid (reduction of Fehling's solution, protein determination).

For such a patient the following courses can be followed:

1. Do nothing. The facial fractures are not treated for fear of creating more intracranial damage. The resulting deformities may be serious. The telescoping of the nasal structures into the ethmoid results not only in a severe saddle deformity of the region, but fre-

Fig. 13.—Comminution in the region of the frontal sinus. A fragment of the posterior wall of the frontal sinus is projected into the frontal lobe (A).

quently also in the widening of the distance between the two inner canthi of the eyes due to an overriding of the ascending processes over the lachrymal bone. The point of attachment of the medial palpebral ligaments is pushed lateralwards. This gives the patient a peculiar Mongoloid look, difficult to correct (Fig. 14). The whole upper maxilla may be pushed back for a distance of as much as one inch with loss of dental occlusion.

2. Reduce the facial fractures, hoping that the spinal fluid will subsequently cease. However, the manipulation may increase intracranial damage.

3. Treat both conditions by a dual approach, close the dural opening through a frontal flap, reduce the facial fractures.

The problem is a difficult one. Many spinal leaks cease spontaneously after a few days. If, however, the dural tear does not close, the patient is in constant danger of meningitis, because there is an open gateway to infection through the intimate relationship of the subarachnoid space with the mucous membrane of the ethmoid or frontal sinuses. Severe deformities of the face and inability to occlude the teeth are serious sequelae to lack of treatment of facial fractures. Marked comminution of the ethmoid may cause an ethmoidal cell wall or a lamina of the roof of the ethmoid to be pushed into the frontal lobe. Sooner or later this spicule may result in brain abscess. It seems, therefore, that a careful evaluation of each individual case is necessary to determine the course of treatment.

Evaluation of Anatomical Damage. A careful stereoscopic x-ray examination and the use of laminographs are necessary to estimate the amount of the damage causing the spinal fluid escape.

The presence of air in the ventricle is a sign of communication between the spinal fluid and the sinuses. The direct pathway to infection is open. An aerocele is an absolute indication for operation.

Extensive comminution in the region of the cribriform plate and the roof of the ethmoid will suggest the penetration of fragments of ethmoidal cells or of frontal bone into the brain (Fig. 13). This is a further indication for operation. In many such cases there is extensive damage to the brain and it is possible to remove the pulped brain tissues at operation.

Operative Procedure. When the dural tear occurs in depressed fractures of the frontal sinus, it is necessary to obliterate the frontal sinus by complete removal of the posterior wall. This results in a severe deformity which is repaired by a subsequent plastic operation.

Dural tears around the cribriform plate can be approached, as practiced by Cairns, through a coronal incision behind the hair line; this avoids scars on the forehead. The cribriform region is approached through a bone flap made above the frontal sinuses which are not entered. The dural opening is closed by a fascia lata graft or by a dural flap, bone fragments are removed and the fracture of the maxilla or the naso-ethmoidal region can be reduced from below by forceful traction under direct observation of the cribriform region from above.

Comminuted Fractures of the Malar Bone. A frequent problem in wartime is the comminuted fracture of the malar bone. This type of injury is distinct from the usual fracture-dislocation of the malar bone which can be readily reduced either through the temporal approach or the oral route behind the tuberosity of the maxilla. Due to the violence of the traumatic blow (airplane crash) or to direct injury (bomb fragment or bullet) the malar bone is comminuted. Numerous fragments are thus displaced and pushed into the subjacent antrum. This results not only in a marked depression of the face but also, and this is more serious from the functional standpoint, a ptosis of the eyeball resulting in temporary or even permanent diplopia. This diplopia may be permanent unless a reconstruction of a floor of the orbit can be done.

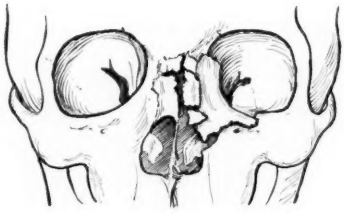

Fig. 14.—Fractures of the nasal bones and ascending process of the maxilla producing a reduction in the width of the left orbit.

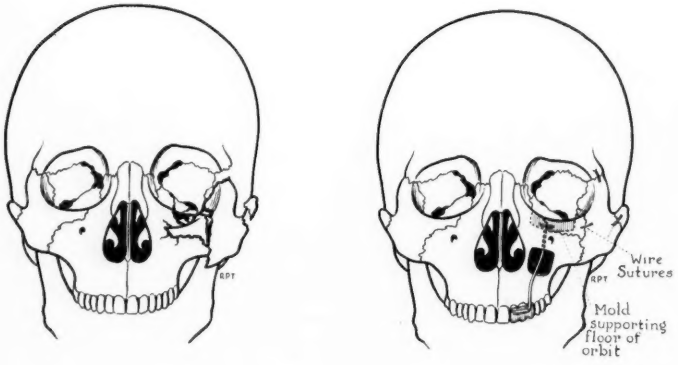

Fig. 15.—Diagrammatic representation of x-ray of comminuted fracture of left malar bone (left) and same fracture after reduction, direct bone suture and cotention by intra-antral mold.

After careful stereoscopic x-ray examination to determine the exact extent of the lesions a dual approach should be made:

1. Through the antrum by a canine fossa opening as in the Caldwell-Luc operation. The hematoma is removed from the antrum and a large window is made into the inferior meatus; this insures drainage. The comminuted fragments of the malar bone can now be seen readily in the roof of the antrum.

2. Through the skin by small incisions made over the site of the fracture lines as seen by x-ray films or through the wound if the fracture is compound. The fracture lines are then exposed to direct examination.

In using this dual approach, one above, one below, it is wise to take care to avoid added contamination to the areas exposed by the facial incisions.

By manipulating the fragments into place through the antrum a replacement can be obtained which is maintained by direct ligature of the fragments through the facial incisions. Wiring is done with Gauge 35 stainless steel wire after drilling a small hole in each fragment with a hand drill or an electric dental engine drill (Fig. 15). The facial incisions are then closed by fine interrupted silk sutures.

Often it is necessary to support the newly reconstructed floor of the orbit either by packing the antrum with vaseline gauze, or what is better, by means of a mold of dental compound or gutta-percha held in position by an extension from a dental splint which passes through the canine fossa opening (Fig. 15). This support should be maintained for from ten days to two weeks.

SUMMARY

The management of certain aspects of war injuries of the face are considered.

The handling of war wounds of the face, of fractures of the facial bones with cerebrospinal rhinorrhea and of comminuted fractures of the malar bone with ptosis of the eyeball are discussed.

Chemotherapy with the sulfonamides has revolutionized war surgery by eliminating the constant menace of the hemolytic streptococcus in war hospitals. It is an added aid in the surgical treatment of war wounds of the face.

121 EAST 60TH STREET.

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LV

ROENTGEN THERAPY OF LARYNGEAL TUBERCULOSIS

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No one specific form of local treatment suffices for all cases of laryngeal tuberculosis. Perhaps the most popular local measure in use today, voice rest excepted, is electrocauterization. Regardless of the type of local treatment decided upon, one must not ignore the fact that the lesion in the larynx is only a part of the general or pulmonary tuberculosis. Laryngeal tuberculosis can not be considered and treated as a localized lesion.

It is universally agreed that laryngeal tuberculosis is practically always secondary to pulmonary tuberculosis. Spencer[15] and Dworetzky[5] maintain that they have never seen a case of laryngeal tuberculosis in which the pulmonary lesion could not be demonstrated, either clinically or by roentgen examination. Although this is true, Myerson[11] states that the patient may not be cognizant of his pulmonary disease but may visit a laryngologist first because of some nodular lesion in his larynx that produces symptoms referable to that organ. He also makes the following assertions: that the laryngeal disease depends largely on the type of the lung disease, that such factors as the nature and extent of the pulmonary lesion, the nature and extent of the laryngeal lesion, the presence or absence of complications, and the successful execution of surgery or pneumothorax are much more important in the healing of the larynx than are any local therapeutic measures. Myerson also comments upon the value of collapse therapy not only as a healing aid but also as a preventive measure in tuberculous laryngitis.

Important in the healing of laryngeal tuberculosis are the nature and extent of the pulmonary disease, a good general resistance on the part of the patient and maintenance of his body weight and his appetite. Wilson[17], however, has pointed out that the laryngeal lesion may show healing although the patient becomes worse generally and dies from his pulmonary disease. His experience has been that the lung condition has never improved while the lesion in the larynx was

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progressing unfavorably. The best results in laryngeal tuberculosis are obtained by the successful treatment of the lung tuberculosis.

Rickmann[13], Ferreri[7], Myerson[11], Spencer[15] and Dworetzky[5] classify tuberculosis of the larynx, some from a clinical point of view, others from a pathological standpoint. All are agreed upon the infiltrative, exudative, proliferative, ulcerative, granulomatous, edematous and perichondritic types of lesions. All grades of severity from hyperemia to necrosis may be included in these types. For the sake of simplicity the classification of Rickmann may be adopted. He recognizes the following types:

1. The productive or proliferative type. In this the lesion is fairly well defined and localized. Usually some degree of organization with a tendency toward healing is present.

2. The exudative type. The lesions in this type are diffuse so that several structures, such as the vocal cords, the epiglottis, and the arytenoid areas, may be the seat of the disease at the same time.

3. The mixed type. In this type both productive and exudative lesions exist in the same larynx. In all three types infiltration and ulceration may be present.

TYPES OF LARYNGEAL LESIONS TREATED BY ROENTGEN RAYS AND REPORTED RESULTS

There is no unanimity of opinion regarding the type of laryngeal lesion that irradiation will improve. The enthusiasm for roentgen therapy and its choice in the different forms of laryngeal tuberculosis varies with the several authors reporting on its use. For example, Debicki[4] believes that most cases of laryngeal tuberculosis are amenable to this form of treatment, even to the obtaining of some degree of amelioration in the grave and destructive lesions. He reports 26 cured larynges in 33 severe cases.

Zange[18, 19] states that in the stationary, predominately productive form the results are excellent but in the progressive, exudative form with the patient's having poor general resistance the results are very bad. He maintains that each case should be selected with consideration being given to the size of the lesion, the type of both the lung and laryngeal tuberculosis and the resistance of the patient. In his opinion curative roentgen therapy is contraindicated in the severe, progressive exudative type of tuberculosis and in perichondritis, especially in the arytenoid region. He says that roentgen treatment, in

small doses, is valuable in the exudative type to secure alleviation of the pain in swallowing. His results in the productive type were excellent regardless of how extensive the lesion, provided the general resistance was good, the lung process was not advancing and the patient's weight and appetite were being maintained. Only one half of the cases of laryngeal tuberculosis seen by him were suitable for roentgen therapy. Of these, in the productive type, cures were obtained in 33% and improvement in 38%. In the exudative type 17% were cured.

In Kriegsmann's[9] series all the patients were in very poor condition. There were 62 patients, 17 of whom died after the first or second roentgen treatment, from their lung disease. Of the remaining 45 cases, 16 were productive in type, 20 were exudative and 9 mixed. Only 5 of his patients had a normal temperature. His object in giving radiation therapy was to relieve the painful swallowing and to increase the food intake. This was accomplished in all cases of the productive type and in 8 of the 9 cases of the mixed type; but in only one half of the cases of the exudative type was there any amelioration.

Matsushita and Usuku[10] believe that the productive type is the best suited to roentgen treatment. Their series comprises 34 patients, 6, or 18%, of which were cured. Two of these had lesions which were exudative in type. Fifteen, or 44%, of their patients were improved; 9, or 26%, were unchanged and 4, or 12%, became worse.

Tavani[16] thinks that roentgen therapy may be employed in the productive (circumscribed infiltrative) type where the pulmonary lesions show a predominately fibrous tendency. He states that it is of no value in ulcerated and edematous larynges where the pulmonary lesions are clearly progressing, and that it is of very doubtful value in the diffuse exudative form or in the productive type if the pulmonary lesions tend to ulcerate. He maintains that radiation therapy is only an adjunct treatment and that the productive lesions benefited by it would be cured with nothing more than good treatment of the general tuberculosis, inasmuch as the improvement in the pulmonary lesion often has a decisive effect on the laryngeal tuberculosis.

Bachmann and Wiegand[2] use roentgen therapy in all types of tuberculous laryngitis.

Becchini[3] thinks that this type of treatment is of benefit in the productive type but not in the exudative type with edema and ulceration.

Rubaltelli and Guarnieri[14] believe that both the productive and exudative types can be helped by radiation therapy, omitting, of course, those patients having a poor general condition with a diffuse progressive form of the disease. A check-up on the larynges of their patients made one year following roentgen treatment showed that: of 10 patients having a severe exudative type, 6 were cured and 4 were dead; of 4 patients having the productive type all were alive. In 2 of these the larynx appeared normal, while in the other 2 a small vegetation was seen in the posterior part of the vocal cord. In 5 patients having a stationary localized infiltrative lesion there was no change.

Gotô[8] agrees with Rickmann that the productive type responds well to radiation therapy but that such treatment is contraindicated in all acute progressive lesions regardless of the type.

Faccini[6] found that his results were much better in the productive than in the exudative type. He believes that his good results depended more on the favorable condition of the patient and on the improvement of the lung disease than on the local treatment of the laryngeal lesion.

Ferreri[7] stresses the importance of roentgen therapy in laryngeal tuberculosis because of its producing a diminution or even a disappearance of the painful swallowing and also because of its ability to cause scar formation. He treats with roentgen rays all types of laryngeal tuberculosis except the serious exudative form. In 25 patients he obtained 6 cures; 12 patients were improved; 3 remained stationary; 2 became worse; and 2 died. He believes that in some exudative forms many weeks and even months may pass before there is any noticeable improvement in the larynx from the roentgen treatment. He does not agree that many of the productive types would be cured by good general therapy only but believes that some of these would go on to the ulcerative and edematous forms. He cites Parola who, treating all types of laryngeal tuberculosis with radiation, states that he has noticed a diminution of the edema and cicatrization of deep ulcers.

Myerson[12] claims that roentgen treatment is most effective in the productive type, a type in which the lesions would heal under good general treatment without the employment of any form of local therapy. His opinion is that active and acute cases are made worse by radiation therapy.

Spencer[15] says that while roentgen therapy may be of benefit, it is not superior to heliotherapy; in fact, he prefers the latter.

Roentgen Dosage. As long ago as 1904, Winkler was using roentgen rays as a treatment for laryngeal tuberculosis. The purpose of this type of treatment, as in any other local therapeutic measure in laryngeal tuberculosis, is twofold: first, to alleviate the pain, and second, to heal the lesions. In most reports some emphasis is placed on the question of dosage. In indicated cases many laryngologists request repeated series of treatments with usually a six- to eight-week rest period between the series. It is the concensus that fractional doses give the best results and are safer than large doses, inasmuch as the dangers of cartilage necrosis and glottic edema are greatly lessened. After irradiation, sufficient regression may take place so that a previously hidden ulcer may come to view. Then too, the patient may be so improved subjectively that he will ask for more radiation therapy. Debicki[4] maintains that the curative action of the roentgen rays consists in the alteration and production of connective tissue.

The cases treated in the series reported here were under the roentgenologic care of Dr. Harry Hauser, Head of the Department of Radiology, City Hospital. Dr. Hauser very kindly consented to write the following explanatory remarks concerning the technic and management he used in the irradiation of these cases.

"On the basis that tuberculous laryngitis is considered a chronic inflammatory process, the rationale for treatment adopted in this series took into account the fact that the inflammatory component could be managed by relatively small doses of roentgen rays and that the chronicity factor could be controlled by multiple doses at relatively long intervals and continued over a period of several months. The physical factors were arbitrarily selected and consisted of 200 kv. potential, 0.75 mm. Cu. plus 2.0 mm. Al filtration (H.V.L. of 0.9 mm. Cu.) and 50 cm. target skin distance. In the early period of this method of treatment a dose of 100 r was administered to each side of the neck every 10 days for 10 treatments. Later only one side of the neck was irradiated with the same dose of 150 roentgens (measured in air) every 10 days alternating sides of the neck for a period of 200 days, or a total dosage of 1500 r (150 r x 10) to each of the two sides. Using a 20 M.A. current, the output delivered was 35 r per minute. Lateral neck portals were utilized and the size of the irradiated fields varied according to the extent of the lesion. The smaller lesions required a field 7 cm. in diameter (38 + square cm.) and the more extensive ones a field of 10 cm. in diameter (78 + square cm.)

"The time intensity factor (150 r every 10 days x 20) precludes the possibility of skin damage. There was no instance in this series of radiodermatitis, and no patient exhibited skin erythema, even though some showed a mild mucous membrane reaction."

Result of Roentgen Therapy. Some of these cases were referred to the hospital for roentgen therapy by the laryngologist at one of the

tuberculosis sanatoriums. In some cases electrocautery had been used locally, previous to the hospital admission, with no improvement in the larynx. The cases treated roentgenologically were not selected discriminately. No particular attention was paid to the type of the laryngeal tuberculosis. In several cases the pulmonary tuberculosis was active and progressing. This may account for the high percentage of cases in which the larynx became worse. The object in mind was to treat several cases of laryngeal tuberculosis with roentgen rays and to note the results. In all, 38 patients were treated; some had the productive type, others the exudative and a few the mixed type. Of the 38 patients, healing of the larynx was secured in 8 cases, or 21%; 6 cases, or 16%, showed improvement in the condition of the larynx; in 8 cases, or 21%, the laryngeal picture remained unchanged and in 16 cases, or 42%, the tuberculosis of the larynx became definitely worse. Such pertinent facts as the age and sex of the patients, the type of laryngeal disease, the lung findings, the type of collapse therapy, the presence or absence of tubercle bacilli in the sputum and the condition of the larynx and the lung following the roentgen treatments of the larynx are noted.

REPORT OF CASES

Two of the cases in which healing of the larynx occurred are of especial interest.

CASE 1. J. P., a colored male, 39 years of age, was admitted to the hospital on December 9, 1939. The roentgen examination of his lungs showed that there was a dense broncho-pneumonic shadow in the left upper lung field with a soft mottling in the remainder of that lung. The area of cavitation in the left upper lung measured 5 x 7 cm. A fairly dense pneumonic shadow was present in the outer half of the right mid-lung field with no evidence of cavitation. The sputum examination was positive for tubercle bacilli throughout his hospital stay. He also had tertiary syphilis.

One month after his admission a left pneumothorax was started. Later on effusion and tuberculous empyema developed.

Seven months after his admission to the hospital he complained of pain in the left side of the larynx, although there had been no hoarseness. On examination of the larynx the left ventricular band was thickened, and ulceration and granulation of the posterior third of the left vocal cord extending into the subglottic region were present.

He was given five roentgen treatments to the larynx, 150 r each, extending over a period of six weeks. They were discontinued because he complained that they made him ill. The larynx, however, healed completely.

Two months after the last roentgen treatment, pain was again experienced in the left side of the larynx. On examining the larynx it was seen that a reactivation of the tuberculous process had occurred. At this time an ulcer was

present on the posterior third of the left vocal cord. Later on the entire left vocal cord and left ventribular band became edematous and ulcerated. Autopsy verified these findings.

Comment. This case is interesting because it demonstrates an ulcerative process in the larynx which healed after five roentgen treatments, only to recur two months after the treatments were discontinued.

CASE 2. M.G., a white female, 30 years of age, was admitted to the hospital on July 6, 1940, at which time she had a 4 x 4.5 cm. cavity adjacent to the right hilum. There was moderately dense mottling in the upper half of both lung fields with less dense mottling throughout the remainder of both lungs. The shadows indicated a mixed type of reaction. Also present was a 3 cm. cavity near the periphery of the left mid-lung field with possible honey-combing above it. The sputum examination for the tubercle bacillus was intermittently positive during her hospitalization.

She was six months pregnant on admission. The pregnancy terminated three months later by spontaneous delivery.

She was given the following treatment: a right pneumothorax on admission, a right pneumolysis seven months later, and a left pneumothorax thirteen months after admission.

When she entered the hospital she complained of hoarseness, pain and difficulty in swallowing. The laryngeal examination revealed ulceration and granulation of both vocal cords with piling up in the interarytenoid space. Roentgen treatments were started but the process in the larynx progressed so that, even after her delivery, the vocal cords and ventricular bands had lost their identity and the glottic space became so narrowed that it was feared a tracheotomy might be necessary. Despite this picture the roentgen therapy was continued. One month later the ulcerations had disappeared from the vocal cords, which were still thickened, but both arytenoid regions were edematous and a granuloma and ulceration were present in the interarytenoid space. From then on the improvemnt in the larynx was remarkable. Three months after the last roentgen treatment the larynx was completely healed and the voice had again become normal. The lung condition improved and she gained 10¾ pounds in the four months following her delivery.

Comment. This case illustrates in a six-months pregnant woman a mixed type of lesion with the exudative form predominating. Noteworthy is the fact that the laryngeal disease progressed while roentgen therapy was being used, even after delivery. Continuance of this type of treatment resulted in a healed larynx.

The following case report taken from the second group, that in which the larynx was improved by roentgen treatment, is representative of the satisfactory result that may be obtained from such treatment. This case is of significance because the original laryngeal lesion, which was of the productive type, was improved by a course

of roentgen therapy. Later on there was reactivation of the laryngeal process with the exudative type predominating. This, too, was improved by a second series of roentgen treatments.

CASE 3. H.M., a white female, 44 years of age, was admitted to the hospital on September 23, 1939. Roentgen studies of her chest showed a 4 x 4.5 cm. cavity behind the right clavicle, surrounded by dense infiltration. There was moderately dense infiltration of the left lung from the clavicle to the diaphragm with a suggestion of multiple small cavities. Sputum examinations were positive for tubercle bacilli.

Routine examination of the larynx disclosed hyperemia of the entire larynx. The left vocal cord was thickened but was not ulcerated. Some edema of the left ventricular band was present. The laryngeal disease was predominately productive in type.

A series of 20 roentgen treatments extending over a period of seven and a half months was given. There was marked improvement in the larynx so that only a very slight thickening of the left vocal cord remained.

Two and a half months after the last treatment the patient became hoarse. The laryngeal examination at this time showed an exudative type of tuberculosis. There was thickening and edema of the anterior commissure; both ventricular bands were red and swollen with some ulceration at the posterior end of the right ventricular band. A second course of 20 roentgen treatments was then given. Following this the larynx improved and the voice became much clearer.

The following case report is of one of the more severe cases of the group in which the larynx was not improved by roentgen therapy.

CASE 4. C.T., a white male, 23 years of age, was admitted to the hospital on May 16, 1937, with extensive bilateral pulmonary disease. Multiple cavitations were present in the upper part of the right lung. Sputum examinations for tubercle bacilli were positive. Three weeks after admission a right pneumothorax was started.

Previous to his hospital admission he had had several electrocauterizations of his larynx. The laryngeal examination showed edema of both arytenoid regions, thickening of the interarytenoid space and ulceration of the epiglottis. This picture remained unchanged during, and after, the roentgen treatments. The active pulmonary disease continued to progress and death ensued.

To be noted in this group is the fact that 5 of the 8 patients were treated with electrocautery either before or after the roentgen therapy was given. In none of them was there any improvement in the larynx from either type of treatment.

The largest group of patients, those in which the larynx became worse following the use of roentgen therapy, comprises 16 cases. In most of these cases the pulmonary disease was of the active, progressive type, which was borne out by the fact that 12 of these patients

died. The following two case reports are representative of this group.

CASE 5. M.H., a colored female, 35 years of age, was admitted to the hospital on May 1, 1940. Roentgen studies of her chest showed an 8 x 12 cm. cavity in the left middle lung field. There was multiple cavitation at the right apex. Tubercle bacilli were present in the sputum.

All structures of the larynx were involved except the epiglottis. The vocal cords and ventricular bands were ulcerated and granulomatous. Five roentgen treatments were given. The process progressed in the larynx so that the base of the epiglottis became ulcerated.

CASE 6. R.W., a white male, 35 years of age, was admitted to the hospital on January 7, 1941, with diffuse infiltration of both lungs and a cavity in the left upper lung. The sputum examination was positive for the tubercle bacillus.

He stated that he had been hoarse for over a year and recently was experiencing severe pain on swallowing. Examination of his larynx showed extensive ulceration of the free border of the epiglottis, edema and ulceration in both arytenoid regions and edema of the aryepiglottic folds.

After the second roentgen treatment the odynphagia increased so that he could scarcely swallow liquids. After the third treatment the entire epiglottis became edematous and ulcerated. Both superior laryngeal nerves were injected with alcohol producing relief of the odynphagia.

In one case in this group the larynx was improved by electrocauterization, although the previous roentgen treatments had made it worse. The larynx improved in one case after the roentgen therapy was discontinued. Injection of the superior laryngeal nerve for odynphagia was necessary in three patients.

SUMMARY AND CONCLUSIONS

1. Laryngeal tuberculosis is practically never primary but is always a part of the general or pulmonary tuberculosis and must be considered and treated as such.

2. Certain factors, such as the character and extent of both the pulmonary and laryngeal disease, good general resistance, and successful collapse therapy, are more important in the healing of the larynx than are any local therapeutic measures.

3. The laryngeal lesion may heal while the pulmonary disease progresses. Eight of the patients in this series obtained healing of their larynges, but in 3 of these the lung condition became worse. In 6 other patients the larynx was improved but in 4 of these the pulmonary disease progressed.

4. In a few cases the lung condition improved while the laryngeal lesion remained unimproved or progressed unfavorably.

5. Laryngeal tuberculosis may be divided into the productive, exudative and mixed types.

6. Opinion regarding the type of laryngeal tuberculosis that will be improved by roentgen therapy varies with the enthusiasm and experience of the different authors.

7. Fractional roentgen doses give better results and are safer than large doses.

8. The cases reported in this series were not selected. Thirty-eight patients were given roentgen therapy. Of these healing of the larynx was secured in 8 cases, or 21%; 6 cases, or 16%, showed improvement in the condition of the larynx; in 8 cases, or 21%, the laryngeal picture remained unchanged; in 16 cases, or 42%, the tuberculosis of the larynx became worse.

9. From the material available one cannot determine the exact type of lesion that will be benefited by roentgen therapy nor can one say that it is superior to other local measures, such as electrocautery. In one case the larynx was improved by electrocauterization after it had been made worse by roentgen treatment. In another unsuccessful case the larynx improved after the roentgen therapy was discontinued.

10. In this series 8 patients obtained healing of their larynges. Of these, 4 cases were of the exudative type, 2 were of the mixed type and 2 were of the productive type.

11. In the 6 patients whose larynges were improved the exudative type was present in 4; the productive type in 1; and in 1 the productive type that later became reactivated and changed to the exudative type.

12. In the 8 cases in which the larynx was unimproved all were the exudative type except one which was the productive type.

13. All 16 cases in which the larynx became worse were of the exudative type.

14. It would be well to give a large series of selected patients roentgen therapy in order to determine what relative value it has as compared with other local measures and also what type of lesion is benefited by it.

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LVI

SOUND TRANSMISSION THROUGH THE EAR AND ITS RELATION TO SOUND INJURY

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It has been found that the initial symptom of a sound injury is a depression of sensitivity of the affected ear in one place of the frequency scale which has been named the "tonal dip." The dip appears most frequently at 4096 c.p.s. Uffenorde[1] was the first to stress the importance of perception of C^5 (4096 c.p.s.) as an initial symptom of perceptive hearing loss. In testing many persons with a sweep frequency audiometer Fowler[2] found depressions of sensitivity to be most frequent between 3000 and 4000 c.p.s.

The first case of tonal dip reported in otological literature is the one described by Lucae[3] in his study of tinnitus. A pianist suffering from tinnitus for seven or eight months consulted Lucae who found that the patient heard the tuning fork C^4 for a period of time 20 seconds shorter than did Lucae; the tuning fork F^4 however, a fourth higher, was perceived for a normal length of time but produced a disagreeable sensation. Lucae diagnosed it as a sound injury and sealed the affected ear against sound for several weeks. He reported that the tinnitus was almost gone and that C^4 was perceived by the patient for as long a time as by the examiner. The case is remarkable because it is reported as a case of tonal dip actually cured.

Numerous are the investigations concerned with "tonal dip". In a recent paper by Wever[4], a review of the theories for the appearance of the tonal dip is presented together with a bibliography to which the reader is referred. Interesting data are presented by Perlman[5] giving the relation of the frequency of the traumatizing tone and the resultant threshold depression. This experiment showed that, with the tests at octave frequencies, the maximum depression in threshold was one octave above the frequency of the fatiguing tone. Dickson[6]

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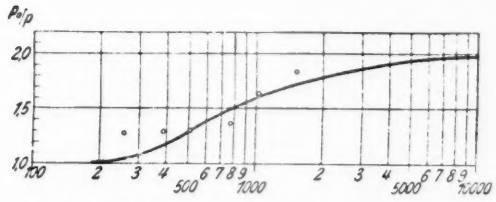


Fig. 1.—Ratio of the pressure at the head p to that which would exist in the undisturbed sound field p_0. (After Békésy.)

and the writer[7] connected the appearance of the tonal dip with the resonance action of the external auditory canal.

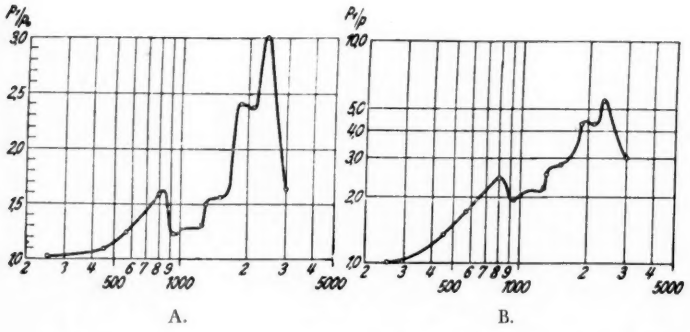
The purpose of this paper is to survey the somewhat scattered data concerned with the quantity of sound transmission to sound perception of normal ears, under normal conditions and under those of sound overload. On the basis of these data, a theory is presented for the appearance to the tonal dip due to sound injury.

Any discussion on quantitative relations between sound energy and sound perception must necessarily clarify the measuring of the auditory threshold and must specify exactly the terms in which the measurements are expressed. This subject has been previously discussed by Sivian and White[8], Geffcken[9], Waetzmann and Keibs[10], Stevens and Davis[11], and others.

1. The threshold of hearing can be expressed in terms of the sound intensity existing in a sound field at which the ear, placed in it, experiences threshold sensation. This is the minimum audible sound field.

2. If a body, the head for instance, is placed in a sound field, the sound pressures on the surface of the body are different from those which would exist in the sound field if the body were not there. Fig. 1 shows the increase of pressure and its dependence on frequency on the surface of the head if the sound source is in front of the ear; this is based on investigations of Ballantine[12], Langenbeck[13] and Békésy[14]. If the corrections of 2 are applied to threshold values in the undisturbed field, the threshold of hearing is then established in terms of sound pressure in front of the external ear canal, with the restriction that we assume that the auditory canal is closed with sound reflecting material.

3. Proceeding one step further, we are interested in the sound pressure existing in front of the drum because this pressure acts im-



A. B.

Fig. 2.—Ratio of the sound pressure at the drum p, to that present a) at the head p. b) in the undisturbed sound field p. The resonance peak in the external auditory canal between 2000 and 3000 c.p.s. (After Békésy.)

mediately upon it and the entire mechanism of hearing. These values are based on the following reasoning. The external auditory canal is, approximately, a narrow tube open at one end where it is flanged; it is terminated on the other end by the drum. The external ear canal is a small cavity exhibiting a certain resonance, which is dependent on the length and width of the canal and on the properties of the termination, the drum. If a sound wave proceeds from the open end to the drum, part of its energy is transmitted, whereas another part is reflected. The amount of reflection and the phase angle of the reflected wave with the incident wave is dependent on the forces opposing the progress of the wave as exhibited by the drum. Those forces which hinder the sound wave in its progress are known as impedance of the drum. Békésy[14] calculated the sound pressure in front of a normal drum using the impedance values of Troeger[15]. In Fig. 2 the relationship of sound pressure in front of the drum to that in the free sound field and to that in front of the external canal respectively are given. The values of Békésy—the Békésy corrections—have been verifiied experimentally by Kuhl[16]. A resonance peak can be seen between 2000 and 3000 c.p.s. The corrections of Békésy can only be applied to threshold measurements on normal ears, and even here, a rather wide margin for error must be permitted because as Waetzmann[10] and his school have demonstrated the impedance values of normal ears may vary considerably. The physiological action of the resonance in the external auditory canal is described by Helmholtz[17], to whom the reader is referred.

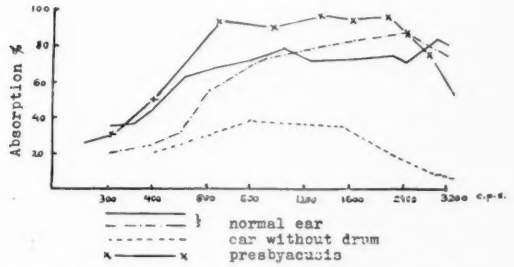


Fig. 3.—Percentage absorption against frequency for two normal ears and two ears with hearing impairment. (After Menzel[17]).

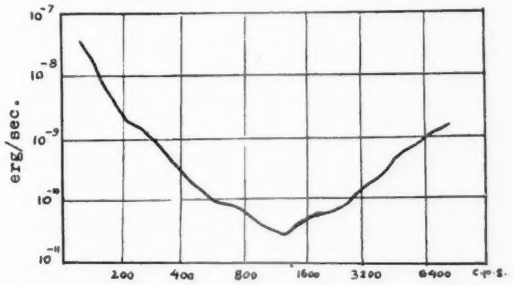


Fig. 4.—Threshold curve of a normal ear in terms of effective, i. e. absorbed energy. (After Waetzmann and Keibs.)

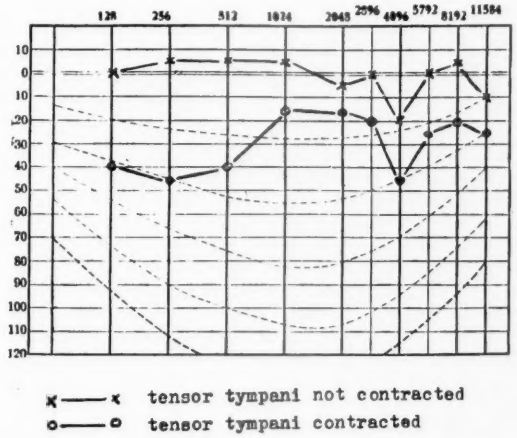


Fig. 5.—Threshold curves of a person with a slight tonal dip at 4096 under normal conditions and with contracted tensor tympani.

4. Now we know the sound pressure in front of the drum. How much of this energy is transmitted into the ear, thereby acting upon the ear mechanism, and how much is reflected back into the external auditory canal? These questions will arise especially if one wishes to learn something about injury by sound energy, since it is obvious that sound energy reflected from the drum can hardly injure the inner ear. The transmission loss of sound energy through the drum is characterized by the absorption coefficient of the drum. As can be seen from Fig. 3, the absorption of sound energy by the drum varies considerably with the frequency. The low frequencies are absorbed less than the high ones. Fig. 3 shows also the sound absorption of an ear without a drum, and that of an ear with presbyacusia, according to investigations by Menzel[18]. It is interesting to know how little energy is absorbed by an ear without a drum as compared with normal ears and those with perceptive hearing loss. Fig. 4 gives the threshold curve of a normal ear in terms of effective, that is, absorbed-sound energy. An inspection of the curve reveals that the sensitivity of the ear in terms of effective energy differs only a little at lower frequencies from the sensitivity at high frequencies. The threshold curve becomes flatter in these terms than in terms of sound pressure in the free field or in front of the drum. This was first demonstrated by Geffcken[9]. The region of highest sensitivity of the ear, as given in Fig. 4, is in the region of resonance of the vibrating system in the middle ear. This is in agreement with Politzer's[20] observations. (The latest value is given by Békésy[19] as being in the neighborhood of 1400 c.p.s.)

Summarizing, it appears that, first, audiometric threshold curves give no information on sound energy actually delivered to the auditory mechanism. If field measurements are made, the threshold curve can be given in terms of sound pressure or energy in the undisturbed field, or in terms of pressure at the head. If pressure measurements are made by the usual clinical procedure of a receiver at the ear, the threshold values should be given in terms of sound pressure measured over an artificial ear with some standard impedance between receiver and calibrated microphone. The values of such an audiogram, given in dynes per cm.^{2} or in decibels referred to an acoustical standard level, would then mean the threshold intensity, not for the tested ear, but that intensity measured over the artificial ear at which the tested ear exhibits threshold sensation. From the above, it is evident that this is as far as we can go in audiometric threshold measurements and we are far from it in clinical audiometry. Any further information on sound energy and its action on the ear is dependent on impedance values of the drum.

Second, the greatest sensitivity of the ear is in the region of resonance of the middle ear, in terms of effective energy.

Third, under normal conditions, the resonance peaks of the external auditory canal and the middle ear are approximately 1000 cycles apart.

Let us now review the behavior of the ear when exposed to excessive noise. The first observations of this kind were made by Bonnafont[21], who observed a hyperemia along the handle of the malleus whenever loud sound impinged on the observed ear. Urbantschitsch[22] reported clonic contraction of the tensor tympani after exposure to injurious sound. The phenomenon was extensively studied by Peyser[23], who found that such contractions may persist for hours after sound injury.

Since it is recognized that a contraction of the middle ear muscles is primarily a defense mechanism[24], it is reasonable to review data on the behavior of the normal ear when the tensor tympani is contracted. Most of the earlier investigators found that a contracted tensor tympani inhibited the transmission of the low frequencies more than the high ones. Urbantschitsch[25] reported reduced perception of the highest as well as the lowest frequencies, implying that there was a region in the middle of the frequency scale where sound transmission was influenced least. A thorough study of sound transmission with contracted tensor was made on animals by Wever and Bray[26]. (The reader is referred to the bibliography in this paper). The investigators found that sound transmission was increasingly reduced whenever more tension was applied to the malleus in the direction of the tensor tympani action. Transmission was reduced for low frequencies as well as for high ones, but a specific area was found which was affected least by contraction of the tensor. This would correspond to the clinical observations of Urbantschitsch. It was also found by Wever and Bray that tensor tympani action increased the natural frequency of the vibratory system in the middle ear as much as 700 c.p.s. An explanation of this important phenomenon is given on the basis of the theory of vibration. The contraction of the tensor increases the stiffness of the vibratory system in the ear; and it is known that an increase in stiffness in a vibratory system results in an increase in its natural frequency also.

As to the resonance of the external auditory canal during the contraction of the tensor tympani, a change in the shape of the resonance curve is to be expected, since there is a change of impedance

of the drum in this state. Békésy[14] calculated the resonance, assuming the condition that the drum was replaced by a rigid termination. This would effect considerably sharper resonance peaks. Measurements of impedance of the drum with contracted tensor are very rare. Besides the qualitative observations made by Lucae[27] with his "interference otoscope", only a few casual data have been published. Geffcken[9] asserted that, in comparison with the normal condition, the reactance component of the impedance is considerably changed, whereas the resistance component undergoes but little change. Data are given for one frequency but, unfortunately, the frequency is not stated. In his investigation of impedance of the drum at very low frequencies Békésy[28] stated that a reflex contraction of the tensor effects a slight increase of impedance for these frequencies. Pending further investigation, one can assume that the resonance peak in the external auditory canal is sharper when the tensor is contracted, since the contraction increases the rigidity of the drum.

Summarizing this data, it appears that:

1. A loud noise effects a contraction of the tensor tympani reflexively, which may persist long after cessation of the injurious noise.

2. Under conditions of contraction of the tensor tympani in normal ears, the sound transmission is reduced at low frequencies as well as high with one minimum in the higher middle range; the natural frequency of the vibratory system in the middle ear is increased; there is reason to assume that the impedance of the drum is changed in such a manner that the resonance peaks in the external ear canal are sharper and higher than under normal conditions.

How does the change of sound transmission with a contracted tensor tympani effect the appearance of the tonal dip?

There is evidence that the natural frequency of the middle ear mechanism approaches the region of the resonance in the external auditory canal. This would facilitate materially the transmission of frequencies in the neighborhood of 2000 c.p.s. relative to other frequencies of the sound spectrum. This, together with the experience of Perlman, would make probable the theory that the tonal dip is a consequence of injuring intensities in that part of the tonal spectrum which is least protected by the reflex reaction of the middle ear against injurious noise. The locus minoris resistentiae is a consequence of the combined action of resonance in the external auditory canal and resonance in the middle ear.

The audiogram presented in Fig. 5 shows a tonal dip at a typical frequency. The person was able to contract the tensor tympani voluntarily. The second curve represents the threshold audiogram with contracted tensor. The least change of threshold is at 2048 c.p.s. The test is a fatiguing one and the person experienced a high-pitched tinnitus, which disappeared in the presence of a masking noise and lasted 30 minutes after the test was finished. This is the same type of tinnitus as that described by Perlman in his clinical experiments.

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Clinical Notes

LVII

TWITCHING OF FACIAL MUSCLES FOLLOWING RADICAL OPERATION OF THE MASTOID

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Spontaneous involuntary cramps or twitchings of facial muscles were often observed in central lesions of the seventh nerve area, such as hemorrhage or tumors of the cerebellopontine angle. It occurs regularly in the syndrome described by Millard-Gubbler[1] where the spasm of the facial nerve is combined with a contralateral paralysis of the limbs. Nielsen[2] states that a recurrent facial spasm may result from a scar on the nerve trunk and it may be difficult in such a spasm to differentiate it from a supranuclear spasm due to a pontine lesion. Occasionally twitchings were also observed in the beginning stage of recovery from Bell's palsy. Jenkins[3] described a case of unilateral facial spasm, associated with tinnitus, of one and one-half years duration; and Atwenger[4] described a patient with facial paralysis and twitchings of facial muscles after psychic irritations and very distinctly after caloric labyrinthine examination of the homolateral ear.

Experimental studies on muscle spasm occurring during recovery from facial palsy in animals were performed on a large scale by Duel[5]. His well-known assumption of a faulty conveyance of impulses through the severed and subsequently repaired facial nerve, as well as his theory carried over from the paleo- and neokinetic system of Hunt, were subject to a wide discussion. In perfectly restored facial nerves in humans neither voluntary nor involuntary spasms were observed during the time of recovery.

I had the opportunity of observing twitchings of facial muscles in a patient where these spasms were produced by increasing the air pressure or by other procedures in a radically operated mastoid.

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REPORT OF A CASE

W. C. H., a 25-year-old mechanic, was admitted to the Illinois Eye and Ear Infirmary in December, 1941, with a neglected bilateral chronic suppurative otorrhea, which he had had since the age of four. The patient had had an earache and headache, especially on the left side, for three weeks prior to admission.

On admission examination revealed a well-developed and well-nourished man with a nearly total destruction of both ear drums, and a mucopurulent secretion from the attic and the antrum. From the left ear the discharge was more abundant and showed cholesteatomatous débris.

Weber's test was lateralized to the left side; Rinne's test was negative for both ears, and bone conduction was prolonged for 20 and 25 seconds. The whispered voice was heard at 10 feet in the right ear and 6 feet in the left ear; the spoken voice at about 15 feet bilaterally. There was no spontaneous nystagmus and the fistula tests were negative. Vestibular tests for both labyrinths showed on turning a normal reaction with typical past pointing.

Roentgenograms of the mastoids showed no direct evidence of normal pneumatic structure on either side. There was considerable postinflammatory change throughout both triangles with some mottling in the upper parts of the triangle and a soft appearance of the bony structures about the antrum, suggesting a low-grade active infection. A possibility of cholesteatoma on the left side was considered.

As a result of these findings a radical mastoid operation was performed on the left ear under ether anesthesia.

The attic-antral space was filled with a large cholesteatoma, which extended posteriorly from the tegmen of the middle fossa down to the mastoid tip. The dura was exposed in the region of the antral tegmen and found normal. The posterior canal wall was taken down and the usual skin flap made.

The postoperative course was normal and no evidence of facial weakness or paresis was noted. The patient made an uneventful recovery and was discharged ambulant after treatment.

On March 5, 1942, about two months after the first operation, the patient was readmitted to the hospital complaining of dizziness for the past two days and headache over the right temple, which came on following a cold of a few days' duration. Before this attack

Fig. 1.—Twitching after pressure at the tragus.

the left ear had apparently been dry, but now both ears had started to discharge. On admission the patient appeared to be very sick. His temperature was 98.2°F., his pulse 56. The patient felt dizzy and had a tendency to fall to the right side. There was a spontaneous nystagmus to the left of first and second degree with a spontaneous past pointing to the right. Hearing was reduced to ten inches for a whispered voice. Low tones of C^1 and C^2 were scarcely perceptible. High tones were markedly reduced. There was no edema over the right mastoid and pressure on the tragus or the mastoid region was painless. The external canal was filled with a pulsating purulent secretion.

The left operative cavity was partly epithelialized and some discharge from the tubal area and the hypotympanum was observed. The facial ridge was partly covered by a soft, slightly bleeding granulation tissue. There were no signs of external otitis.

On the second day after admission the spontaneous nystagmus persisted, but was only of first degree. After calorization of the right ear with cold alcohol the spontaneous nystagmus of first degree turned to a third-degree nystagmus with intensive past pointing to the right side. The fistula test of the right ear was negative.

Pressure on the left tragus and compression of air into the left external canal (fistula test) resulted in a twitching of the facial

muscles of the left side. It started with fibrillary twitchings around the left eye and proceeded with the nasal and labial muscles. On release of this pressure the twitching subsided. This twitching could also be produced by slight pressure on the granulations located at the facial ridge. It was demonstrated for a period of 11 days in variable strength.

At this time the spontaneous nystagmus from the right ear subsided and the discharge in both ears diminished.

The patient received sulfonamides continuously until the serous labyrinthitis of the right ear had cleared up.

Seven weeks after the acute exacerbation of the right ear infection a modified radical operation was performed. The middle ear was left untouched and the bridge was not taken down. The attic and mastoid were found full of granulations. There was no fistula visible at the horizontal canal. The postoperative course was satisfactory and the patient was discharged ten days later. The left ear still showed a granuloma at the facial ridge and some pus from the tubal region, but no further twitchings could be produced.

The patient was seen recently and exhibited a well-epidermized right mastoid; the left radical cavity was still discharging and a flat granuloma persisted at the anterior part of the facial ridge. No twitching could be produced by compression of air or by pressure on the tragus.

CONCLUSIONS

Anatomically the facial nerve seems to have been exposed in the geniculo-foraminal region below the posterior iter of the chorda tympani. The location was marked by a granuloma partly covering the facial ridge.

In this area the position of the branches of the facial nerve are so arranged that the superior ramus lies superficially in the frontolateral position and the inferior branch medioposteriorly[6]. The superior branch carrying the eye fibers was at first exposed to the pressure and responded promptly with a fibrillar twitching of the orbicular muscles. By increasing the pressure in the aural cavity the fibers of the inferior branch were also affected and produced muscle twitchings in the oronasal region.

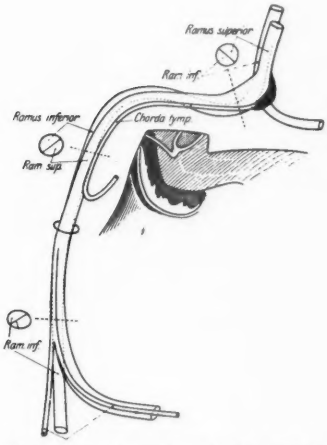

Fig. 2.—Drawing illustrating the position of the branches of the facial nerve according to Hoffman.

From a pathological point of view it seems difficult to determine whether, and to what extent, the nerve was exposed during the operation. A previous destruction of the fallopian canal in this area through a cholesteatoma or a bony absorption during the last exacerbation should be considered as a possibility.

Bony dehiscences in the region below the posterior iter are almost nonexistent.

The repeated reproduction of twitchings of the facial muscles on pressure at the tragus, on compression of air in the mastoid cavity and on touch confirms the old theory that the free exposed uninjured nerve does not necessarily cause a supervenient paralysis. This is contradictory to the belief of Richards[7].

We should also keep in mind that facial spasms can be caused by reflex irritation of the trigeminus nerve; in this case, however, touching a skinless granulation over a bony area adds little to this explanation.

Physiopathologically I should like to agree with Marburg[8] that these twitchings of the facial muscles were produced by some irritability of the neuromotor units of the free lying nerve in the partly destroyed bony fallopian canal.

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LVIII

ACUTE INTRACRANIAL LESIONS SIMULATING TUBERCULOUS MENINGITIS

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Tuberculous meningitis is not an uncommon disease in children. In his report from Queen's Hospital for Children, Kinnear[1] states that tuberculous meningitis accounted for nine per cent of the deaths in their medical wards in 1923. The difficulty of making a diagnosis during the early stages not only causes pediatricians considerable anxiety, but may be particularly distressing to the otologist who is called in consultation on account of the coincidence of middle ear infection. Particularly is this true when the apparently normal child is suddenly stricken with a convulsion and paralysis.

It must be borne in mind that tuberculous meningitis strikes so suddenly that the child may never have presented any previous signs or symptoms of the tuberculous infection. It is the exception for these children to be noticeably underweight, and, aside from lack of energy and night cries, there is nothing in their behavior which would even suggest that the child has been ill. Individual signs and symptoms are not distinctive of any particular intracranial lesion, and it is only when in combination that they point to the diagnosis.

When the infected ear, for the time being, draws the major attention, it is difficult to draw the line between the symptoms caused by the ear and those due to the meningitis. In Kinnear's[1] report the symptoms and signs occurred in his patients in the following percentages:

Vomiting	89%	Babinski's sign	31%
Constipation	81%	Screaming	29%
Strabismus	30%	Convulsions	29%
Headache	80%	Absence of knee jerks	27%
Stiffness of neck	65%	Absence of abdominal reflexes	20%
Kernig's sign	51%	Twitchings	15%
Head retraction	35%		

The age incidence in Kinnear's[1] report was as follows:

0-1 Years	18%	4 -5 Years	12%
1-2 Years	24%	5 -10 Years	10%
2-3 Years	18%	10-14 Years	7%
3-4 Years	11%		

I have been impressed with the difficulties encountered in the diagnosis of tuberculous meningitis and have reviewed a series of cases which I have seen principally on account of the ear infection.

To me, the disease most difficult to differentiate from tuberculous meningitis is brain abscess; this confusion exists not on account of the close resemblance of the symptoms to those of meningeal irritation, but because the patient with tuberculous meningitis presents symptoms and signs which lead one away from the thought of any kind of meningitis. Fortunately, we are learning that the urge for emergency surgery in brain abscess is not well grounded, as Dandy[2] has so well brought out, and that closes another argument of the anxious operator.

Lund[3] states that, "Tuberculosis, since it is the most frequent chronic infectious disease, often gives rise to diagnostic problems, inasmuch as the combination of middle ear suppuration and tuberculous meningitis is quite common."

At the Municipal Hospital in Copenhagen, in two decades, 52 patients with tuberculous meningitis were admitted for observation for otogenous intracranial complications. The symptoms chiefly called attention to the possibility of brain abscess. In 8 of the cases diagnosis could be made only on explorative operation.

REPORT OF CASES

Brain Abscess

CASE 1. I was called to see a three-and-one-half-year-old boy who was having convulsions. Two months previously the child had had a severe earache and a slight sore throat. He then began having chills twice a day which lasted for three weeks, but these were stopped by the administration of quinine. He had not been well since that time but had had no definite complaint and, although he had a very poor appetite, he did not lose weight. The earache was relieved by spontaneous rupture of the drum and there was a moderate discharge which lasted for about two weeks. The father had noticed a foul-

smelling discharge from the left ear the day before I first saw him. The morning of the day previous to my first visit, the child had fainted twice and I noticed some twitching of his lower extremities. He did not regain consciousness after this second fainting spell and was irrational all day. He slept very poorly that night, cried out in his sleep, and refused food. His bowels had been constipated, but there was no vomiting. He had a temperature of 97.6°F., and a pulse rate of 70. There was no rigidity of his neck, and the reflexes were normal.

With this very startling ear history and chills two months previously, I was certain that I was dealing with a brain abscess. The child was immediately taken to the hospital and a left mastoidectomy was performed. The mastoid cells were filled with pus and the dura of the middle cranial fossa was inflamed. The sigmoid sinus was smooth, blue, and collapsed on inspiration. The brain was explored completely beneath the posterior and anterior fossae. I also explored both parietal lobes. No abscess was found. The child left the operating table in good condition.

The following morning his temperature was 103°F., and his pulse rate was 110. The child slept fairly well during the night but would cry out occasionally. There was an intermittent twitching of the muscles of the left leg. While there was a slight improvement in the general condition, I attributed it to the effect of the decompression. The child continued to have convulsions, had a fever of 98.6°F. to 102°F., the pulse rate increased to 160, and respiration was between 40 and 50.

Comment. This child died eight days following admission to the hospital, and at necropsy the lungs and spleen were covered with miliary tubercles. There was mesenteric tuberculosis and an old mediastinal lymphatic tuberculosis. All of the intracranial symptoms that so closely simulated a brain abscess were explained by tuberculous meningitis. There was no thrombosis in any of the intracranial sinuses, and it is difficult to explain just why the child should have had repeated chills at the onset of the disease, unless it was the active tuberculous infection. Blood smears were negative for malaria.

Pneumococcic Meningitis

Pneumococcic meningitis may so closely simulate tuberculous meningitis that in the early stages it is impossible to make a differential diagnosis. Even the spinal fluid may reveal no organisms and a relatively low cell count. This is especially true when the patient has

almost recovered from the initial pulmonary lesion and has developed a relative immunity to the pneumococcus. A meningeal involvement comes on during the early stages of a slow, but apparently normal, convalescence. The child is usually emaciated and, in spite of the fact that this is not necessarily the clinical picture of tuberculous meningitis, yet the emaciation is apt to impress one as the common tuberculous picture. The following is an account of such a case.

CASE 2. G. H., a five-year-old boy, was brought to Isolation Hospital with delirium, fever and a stiff neck. When I first saw him he had a fixed stare and his eyes were deeply sunken. He was markedly emaciated, had a distended abdomen, a positive Kernig's sign on his left side, and was so restless that he had to be restrained in bed.

Lumbar puncture revealed a clear fluid, a cell count of 56, and no organisms. On repeated punctures the cell count increased to 160, and numerous organisms were found on the fourth puncture, which on direct smear were thought to be streptococci. I was inclined to accept this bacteriological finding with some doubt and thought perhaps that it was due either to the infection from the repeated lumbar punctures or the contamination of the spinal fluid. I was also reluctant to release my diagnosis of tuberculous meningitis, when I learned that a member of the immediate family had active tuberculosis.

The child died three days later, and the autopsy revealed an abscess in the right pleural cavity adjacent to the dome of the diaphragm. On culture the organisms of the spinal fluid were found to be pneumococci.

Comment. The slow progress of the intracranial disease was typical of the activity, as the streptococcus is a much more rapid destroyer within the cranial vault. While there was no evidence of any extensive pneumonia, yet this child had definitely had pneumonia.

Otitic Meningitis

The following is a typical case of tuberculous meningitis in which the symptoms and signs at the onset of the disease simulated an otitic type of meningitis.

CASE 3. A four-year-old boy, who had just returned with his parents from a motor trip, was suddenly taken ill with an acute cold, sore throat and bilateral earache. There was spontaneous rupture of the drums but his temperature remained around 103°F. He became delirious, was extremely restless and irritable, and called continuously for his mother. He had no convulsions and had not been unconscious.

I saw this patient at this time and made a diagnosis of otitic meningitis. The patient was taken to the hospital. A lumbar puncture showed 120 cells in a clear spinal fluid. With this spinal fluid finding, it was quite evident that the child did not have an otitic meningitis. He had continuous convulsive movements of his entire right side, incontinence of urine and feces, shallow labored respiration. He died a few days later during a very severe convulsion with a terminal temperature of 109°F.

Comment. Necropsy revealed an extensive tuberculous meningitis. There were old pleural adhesions at the posterior base of the left lung, and sections through this area showed an advanced tuberculosis. The liver was covered with metastatic tubercles. There was pus in both mastoids, which upon staining showed streptococci.

Cerebral Embolism

The following case is one of endocarditis and cerebral embolism simulating tuberculous meningitis.

CASE 4. A ten-year-old boy, who was under-developed mentally, was admitted to the hospital on account of a discharging right ear of one year's duration, and he had had an acute exacerbation ten days prior to admission with profuse discharge. He had had slight chills, with a mild temperature elevation, for about three weeks. The white blood count ranged from 5,200 to 9,800. His spinal fluid was clear, with an increased pressure and 15 cells. The Wassermann test was negative; urinalysis was negative. An x-ray film of the mastoid process showed evidence of an old involvement with breaking down of the trabeculae. The patient did not give a complete picture of sinus thrombosis. The history of the chills was a bit uncertain. The low white blood count and the drowsiness did not fit the picture.

After two days' observation, I elected to open his right mastoid and expose the dura and the sigmoid sinus. The usual infected mastoid process was found and there was nothing abnormal about the dura of the middle cranial fossa or the sigmoid sinus. The patient made no improvement following the operation, and there were temperature excursions from 103°F. to 106°F. He was stuporous, developed an intermittent spastic paralysis of the left leg and arm, had continuous thrashing of his left leg and screamed out. There were occasional short intervals when he seemed to be improving.

Comment. Prior to his death, on the fifth day, he was unconscious for 48 hours, with a complete paralysis of his left side. Necropsy revealed a bacterial endocarditis with multiple cerebral emboli.

Meningococcic Meningitis

CASE 5. A twelve-year-old boy was admitted to St. Margaret's Hospital on account of pain in his right ear and stiffness of his neck. During Christmas week he had some earache, which was very severe and lasted about a week. He was taken to a doctor who incised his ear drum and took out his tonsils and adenoids. The ear began to discharge and he was better for four days. Then his neck became stiff. There was a tenderness over his right mastoid and he had a marked photophobia.

These symptoms cleared up in a few days and he then developed a severe occipital and frontal headache. He vomited several times, had a slow pulse, was very drowsy and was bothered with night terrors. The temperature ranged from 101°F. to 104°F. His bowels had moved only twice in the last 13 days. He complained of being dizzy and said that objects were moving about in the room. He was pale and thin, and his face was drawn as if in severe pain. There were no convulsions. The urinalysis was negative, and the white blood count was 16,000. His spinal fluid was turbid and under increased pressure, and a cell count of 2700 was found. The Wassermann test was negative. No bacteria could be found.

A mastoidectomy was performed and a large dural exposure was made over the middle cranial fossa, after which the patient temporarily improved. He complained of backache and vomited occasionally. After intermittent and temporary improvement for about four days the patient died.

Comment. Epidemic meningitis may, in its early stages, be confused with tuberculous meningitis, but the spinal fluid findings are so diagnostic of the disease that rarely does the confusion last very long. In the primary stage otitic meningitis and brain abscess were first thought to be the cause of the unusual symptoms. After the patient died, tuberculous meningitis was seriously considered, but it was discovered at necropsy that the child had died of meningococcic meningitis, and also a meningococcic infection of the mastoid process.

Brain Tumor Simulating Tuberculous Meningitis

Since a tumor may involve any part in the brain and exhibit the symptoms and signs of any intracranial lesion, it is not surprising that

tuberculous meningitis may be diagnosed as a brain tumor, or that a brain tumor may be diagnosed as tuberculous meningitis. Even the age of the patient might cause one to draw the wrong conclusions, as is well illustrated by the following cases:

CASE 6. A mother brought her 19-month-old son to Mercy Hospital on account of paralysis of the left leg and arm. She gave the following history: The child was a breast-fed, full term, healthy baby. Two weeks prior to admission, the boy suddenly developed a high fever, and the mother thought he had a headache, as he continued to put his hand to the front of his head and held his head constantly to the right side. During this time he had no convulsions, but his fever remained high and he was very sick for four or five days. Suddenly there was a profuse, thin, yellowish discharge from the nose, and his mother noticed that his left leg and arm were paralyzed. His fever quickly subsided and he appeared to be better.

Following his admission to the hospital, he had practically a normal temperature, the highest being 100° F., a white blood count of 10,200. The spinal fluid showed a slight increase of pressure, and he had 17 cells per cc. He held his left hand tightly closed and there was a spastic condition of his left leg. He was unable to walk and did not stand in his crib. He did not appear very sick but was quite irritable.

There was a profuse, yellowish, thin discharge from the left naris, which appeared to come from the middle meatus. The mucous membrane was semi-atrophic, and the organisms seemed to be destructive. There was a moderate discharge from the right naris. The pharynx was red and congested, and there was a postnasal discharge. The ears and tonsils were negative. No swelling, redness or apparent tenderness over any of the accessory sinuses was noted.

Suddenly, without warning, two weeks after his admission, his temperature rose to 105° F. He became comatose, had a shallow, rapid respiration, and died 48 hours later without regaining consciousness. It was not until after his death that I even thought of the possibility of tuberculous meningitis, as his sudden expiration convinced me that a brain abscess had ruptured into the ventricle or subarachnoid space, and had produced the high fever, meningitis and death.

Comment. Much to my surprise the autopsy did not bear this out. He had a soft glioma, half as large as a hen's egg, occupying the right temporoparietal lobe, which brought about a marked increase in the intracranial and intraventricular pressure. The cerebrospinal fluid spurted several feet when the brain was incised down to the ventricle. This tumor accounted for all the symptoms and signs.

A profuse, thin yellowish discharge from the left naris led me to believe that this child had a brain abscess which was secondary to his nasal sinus suppuration.

Tuberculous Meningitis Simulating Brain Tumor

CASE 7. A patient, aged 71, was admitted to St. Luke's Hospital, unconscious. Six weeks before he had had a nasal operation and some tissue was removed. This was followed by considerable pain in his head. His relatives did not know what was done at this operation and it could not be determined by examination. He continued to work in the meantime, up until four days prior to his hospital admission, when he became unable to walk and fell forward several times when attempting to go to the bathroom.

Three weeks before admission he developed severe headaches in the left orbital region, which radiated backwards. These were persistent and became progressively worse. He gradually lost his hearing and developed a complete paralysis of the right side of his face. His hands and arms became spastic, and his neck rigid. Two days prior to his hospital admission he developed incontinence of urine and feces, and became unconscious.

His past history was entirely negative except for a sore in the roof of his mouth which had been cauterized about six months previously, and, at the same time, he had a similar lesion on the back of his neck. These healed promptly and left only a moderate amount of scar.

The most conspicuous findings were the marked distension of his abdomen, his facial paralysis, and the incontinence of urine and feces. His blood pressure was 130/90; pulse, 120; respiration, 40; and his temperature, 101°F. Blood chemistry and urinalysis were normal. He had 13,400 leukocytes; 4,080,000 red blood cells; 80% hemoglobin. The spinal fluid, under normal pressure, had 158 cells, which were mostly mononuclear. Gold chloride and Wassermann tests of this fluid were negative, as well as the cultures and smears. The patient resisted any examination, and it was impossible to examine his eyegrounds. The pupils were unequal and contracted, and reacted slowly to light. After examining the patient, I could not differentiate between a brain tumor, brain abscess, encephalitis, luetic meningitis or tuberculous meningitis.

The patient was much worse the evening following his admission to the hospital. His temperature rose to 103.6°F., and he looked

as if he were dying. The following morning, much to my surprise, when I spoke his name he recognized it and tried to answer me. His wife said that he knew her and she was quite elated over his marked improvement. The rigidity of his neck had almost completely disappeared, and he drank a considerable amount of fluid. His temperature dropped to 101°F., and it looked as if he might recover. That night, however, he became much worse; his temperature went to 107°F., and he expired the following day. There was no important change in the laboratory findings, and the cultures and spinal fluid were sterile.

Comment. In the order of frequency, according to their age, the diseases in these last two patients should have been reversed. This 71-year-old man should have had the brain tumor and the 19-month-old boy should have had the tuberculous meningitis. Brain abscess could not be ruled out in either case, as the symptoms and signs would very properly fulfill all requirements necessary to make a diagnosis in either case. Had a necropsy not been performed on either of these patients the correct diagnosis not only would have never been made, but the erroneous conclusions would have been fortified by the improper interpretation of the very typical signs and symptoms.

Poliomyelitis

Holt[4] states that the differentiation of tuberculous meningitis from the meningeal form of poliomyelitis may be very difficult owing to the similarity of the spinal fluid in the two diseases. The seasonal variations may help here as poliomyelitis reaches its peak in the late summer and early fall and tuberculous meningitis reaches its height in March and the spring months. The prevalence of the former disease in a given locality is also of distinct help and should always be considered.

CASE 8. I was called to do an emergency tracheotomy upon an eight-year-old boy who had been acutely ill for four days with vomiting and high fever. The night previous he had been delirious, very restless and had had a convulsion. Following this convulsion he developed a marked respiratory distress, became cyanotic, and, one hour before I saw him, his parents thought that he was dying. Considerable pink, frothy mucus was wiped out of his throat and, although his condition had improved, he was still very cyanotic when I first saw him. He was unconscious, the respiratory rate was about 50 per minute, he had a typical death rattle in his trachea, yet his pulse was of good volume with a rate of 120. The pupils were pinpoint in

size, and I learned from his parents that he had been given an unknown amount of morphine four hours previously for his restlessness. There was no laryngeal obstruction.

While I was watching him, he suddenly stopped breathing and, when I lifted him up and let his head hang down, about eight ounces of pink, bloody froth drained out of his mouth. His color immediately improved. He awakened and seemed to recognize those around him, and the rattle in his throat disappeared. All over his chest moist crackling râles could be heard. The most conspicuous finding was the scaphoid, or boat-shaped, abdomen. His eyes were sunken and he was somewhat emaciated. I thought that I could palpate his spleen. There were no reflex disturbances and no evidence of paralysis. I asked his mother if there was any tuberculosis in the family and this she promptly denied.

The child was brought to the hospital and more of this mucus was aspirated from his throat. He became drowsy, was again semidelirious, had a temperature of 104°F., a leukocyte count of 10,000, and normal urine. X-ray films of his chest revealed only the presence of secretion in his bronchi. That night at midnight he suddenly seemed to get much better, drank orange juice and water freely, and slept quietly for about four hours. All along I had the impression that this boy was suffering from a tuberculous meningitis, and I was firmly convinced the following morning when the mother confessed that her brother and sister had died of tuberculosis and that the boy's father had lost two brothers of the same disease.

The child got progressively worse, with a temperature rise to 106°F. He had difficulty in swallowing, had urinary incontinence, vomited, was very restless. When his spinal fluid was drawn, there was a moderate increase in pressure; it was clear, with 90 cells, most of which were mononuclear.

Further history from the mother revealed that the boy had never been well, had suffered for months with headaches, that he had always had a poor appetite, vomited easily, and tired quickly on exertion.

He died 24 hours after admission and, at necropsy, what was thought to be a tuberculous meningitis as a complication of a diffuse miliary tuberculosis was found. Later examination of slides by the pathologist showed that the boy had had poliomyelitis.

Comment. The previous history of such a case of tuberculous meningitis with confirmation of the diagnosis by necropsy is so typical of the disease that it is hardly worth commenting upon.

The attending pediatrician had suggested throughout the course of the illness that the child might be suffering from poliomyelitis, but even he conceded the diagnosis of tuberculous meningitis when he saw what we took to be miliary tubercles beneath the serosa of the intestine. Microscopic examination did not demonstrate them to be tubercles but the very common lesion that is found in poliomyelitis.

Encephalitis

Encephalitis may resemble, in its early stages, any intracranial lesion and is frequently confused with tuberculous meningitis. The symptoms of the following case not only simulated tuberculous meningitis at the onset of the disease, but throughout the course of the illness the signs and symptoms were very typical of the lesion. The fact that this patient recovered was the only evidence that was contradictory.

CASE 9. G. B., was first seen in consultation on account of earache and the following history:

Ten days previously, while on his way to school, he complained of being tired and said that his head hurt. He sat down on the curb and his brothers and sisters went on to school and left him. He managed to get on to school but told the teacher that he was sick. That night he complained of headache, and vomited, and his mother noticed that his left ear was draining. Two days later, on account of a high fever and continued headache, a doctor was called who lanced the drum of the draining ear. Consultation was called, and altogether four drum incisions were made.

When I saw the boy he was quite alert, inclined to be playful, and had a temperature of 102° F. His left eardrum was bulging, and on incision thick yellow pus oozed out. There was a large triangular perforation about the center of the drum which had been repeatedly incised, but no discharge was coming from the ear. His right eye turned in, but a photograph taken some time before showed that this was normal. He said that he had a headache and pointed to his eyes. I assumed that this undrained suppuration of his left ear accounted for his symptoms, and advised his parents accordingly.

The following day he was comfortable, his temperature did not go above 102° F., but that night he became very restless, cried out in his sleep, and the following afternoon at two o'clock he had a hard convulsion. When I saw him that evening, he had a rigid neck, a

marked ankle clonus, and a flaccid paralysis of his right arm. He was drowsy and difficult to arouse. There was no drainage from either ear. He was taken to the hospital and a spinal puncture showed a normal fluid. The other laboratory findings were negative. His temperature ranged from 101°F. to 103°F., and he was very listless and drowsy. His pulse was 96.

X-ray pictures of his skull and mastoid were negative. The question now arose as to whether the child had a brain abscess or tuberculous meningitis. I felt certain that he had the latter. Certainly, the mastoiditis without complications could not account for his symptoms, and I elected to stand by and watch developments, especially since the child presented such a classical picture of tuberculous meningitis. I was well repaid, as the child made a complete recovery and has been well since.

Comment. What this boy had was an acute encephalitis, and within a month I saw three similar cases, two of which recovered. I feel certain that the reported recoveries of tuberculous meningitis were similar to this case and should have been diagnosed as encephalitis.

SUMMARY

Brain abscess, pneumococcic meningitis, otitic meningitis, cerebral embolism, meningococcic meningitis, tumor of the brain, poliomyelitis and encephalitis may frequently simulate tuberculous meningitis. Patients with tuberculous meningitis often have, as a mere coincidence, acute middle ear infection.

Exploration for a brain abscess may be justifiable, but a better understanding of the clinical course of tuberculous meningitis should prevent such an unnecessary operation. Rarely does a brain abscess require such emergency measures that the surgeon does not have time for a more careful observation.

Since tuberculous meningitis is always a fatal disease, the diagnosis should be made very reluctantly, and the recovery of the patient should always be accepted as positive proof of an error in diagnosis.

The otologist should be familiar with non-otogenic sources of intracranial complications and should carefully weigh the evidence before performing any operation upon the mastoid process, or exploring for a brain abscess.

1617 PROFESSIONAL BUILDING.

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LIX

MASKING EFFECTS OF THE SULFONAMIDES IN OTOGENOUS INFECTIONS

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The unquestionable reduction in the incidence of mastoiditis through the early judicious use of sulfonamides in acute otitis media is universally recognized. Acute middle ear infections secondary to acute upper respiratory infections have responded remarkably well to the drug. But previous to the advent of sulfonamides mastoiditis followed in only 5% of the cases of acute otitis media. Page[1] in 1934, in a statistical report of 836 cases of acute otitis media, showed that 5.1% required operation of the mastoid. The most prevalent infection and the largest number of mastoidectomies were caused by streptococcus haemolyticus. Pneumoccus, type III, caused the highest proportion of mastoidectomies. These cases were reported before the advent of the sulfonamides. Recognition of this fact indicates that the reduction of mastoid involvement occurs in the 5% group rather than in the 95% group that formerly spontaneously resolved. If we admit that our simple clinical measures were formerly responsible for the cure of 95% of the cases of otitis media, it then must be apparent that to attribute all cures to sulfonamides is erroneous. This becomes more serious when it is subsequently reflected in our attitude toward treatment by the uncontrolled use of these drugs. No wonder, then, that the untrained, faith-blinded laity have been taught to demand a sulfonamide of some kind at the onset of acute infections because of the apparent but unreal interpretation of previous recoveries.

In 1939, Maybaum, Snyder and Coleman[4, 5] published an article based on two years of intensive experience and investigation on the masking effect of sulfonamides on otogenous infections. They wrote:

"We suggest to those who are of the opinion that sulfanilamide should be given from the very beginning of otitis media, that the patients be carefully observed over an extended period, despite apparent improvement in the otitic picture and absence

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From the Service of Dr. Daniel S. Cunning, Manhattan Ear and Throat Hospital, New York City.

of symptoms; furthermore, as a therapeutic test, we advise the discontinuance of the drug for a few days during the period of observation to note whether a recrudescence of signs or symptoms of postauricular infection occurs."

Many of the observations in this paper have been repeatedly confirmed by subsequent clinical experience by otologists everywhere. Converse[3] in 1939 indicated the recurrence of otitic infections due to hemolytic streptococcus following inadequate sulfonamide therapy. Bowers[2] in 1940 stated "At times it is necessary to stop the drug in order to obtain a true picture, as the drug cures the middle ear, while progressive bone destruction is taking place in the mastoid."

Despite repeated warnings there is a decided neglect of the potential dynamite of the drug because it is considered socially necessary to use it. The social reasons for the use of the drug are most unfortunate. The doctor feels compelled to use it for fear of being reproached by the patient's family and friends in the event of complication. With proper simple explanation the lay mind can readily understand the reason for hesitation and need not feel that a possible subsequent complication is a reflection on the doctor. One must remember that social bias is not an accepted indication for the use of any drug. It is the neglect of the warning that the free use of sulfonamides, aside from the dangers of toxicity, tends to obscure the clinical picture and often gives rise to a latent course of disease that is responsible for the overwhelming pathology as in the cases to be reported here.

Especially is the masking of the clinical picture noted in otogenous infections caused by pneumococcus, type III. The characteristic insidious clinical picture due to this organism is that of no fever, no headache, and no tenderness over the mastoid. The absence of such clinical findings is often noted in cases with extensive cellular destruction. These same misleading factors also occur with the use of sulfonamide therapy. The analgesic and antipyritic properties of the drug are well recognized. We must then realize how significantly altered must be our judgment when the two factors are combined; namely, the insidiousness of the pneumococcus and the masking effect of the sulfonamide.

It might not be amiss at this time to indicate that numerous experiences of otologists everywhere have caused them to be aware of the masking effect of the drug even when a mastoidectomy has been performed. The sulfonamides were given freely following surgery of the mastoid even in those cases that showed no evidence of complications. Complications, when they did occur, were either completely hidden or sufficiently masked to distort the criteria for more exten-

sive surgery. And thus the operative procedure was delayed for a longer period than would ordinarily be allowed to elapse. Following simple mastoidectomy, it is therefore advisable in uncomplicated cases not to give the drug. In the event of complications, such as lateral sinus thrombosis or petrositis, the limit of surgical measures must be reached before the drug can safely be given.

It would be audacious to minimize what has been accomplished by the drug in the treatment of meningitis after a suppurative focus has been removed surgically. Yet it is most interesting to note that in innumerable cases of meningitis reported cured by a sulfonamide one can accuse this same drug, the misguided use of which was indirectly responsible for the development of the disease itself by having masked symptoms that would ordinarily have indicated earlier surgery.

A typical sequence might be obtained by creating a story which is a compilation of many histories. Following an acute upper respiratory infection which is treated by home remedies for a few days, the patient complains of pain in the ear. The local physician finds a full drum and a rhinopharyngitis. A sulfonamide is prescribed in varying doses, often not sufficient to control the infection but enough to assuage the conscience and return the temperature to normal. The analgesic effect of the drug diminishes the pain and gives the patient, the family and the physician a false sense of security. After a few days of relative freedom from pain, the drug is stopped. If the patient returns to complete health, the recovery is attributed to the drug. If, on the other hand, there is recurrence of pain and fever after a few days the drug is resumed, with some trepidation. It was at this period in the progress of otitis media that myringotomy often was beneficial. Under sulfonamide therapy, however, myringotomy, although indicated, is postponed from day to day, always in the hope that the eventual cure lies in the sulfonamide. In fact, this sulfonamide therapy is often repeated five or six times, particularly in pneumococcal infections. Sometimes weeks, and even months, pass before an otologist is consulted. He finds a latent masked mastoiditis or other otogenous complications. At operation extensive pathological changes are found. Often the pathology is not limited to the mastoid but involves the lateral sinus, the dura, and even the cortex of the brain and the meninges.

The accepted concept of the attenuation of the virulence of various organisms by the sulfonamides must make us look the more carefully for less obvious manifestations of disease that formerly were so significant clinically.

The general practitioner unquestionably is the largest user of sulfonamides in acute upper respiratory infections. He must recognize that the optimum action of the drug occurs during the period of hyperemia of the middle ear when there is no actual pus. Once suppuration has occurred the efficacy of the drug diminishes. The concentration of the sulfonamides in fat, pus, and bone is notoriously low. Under sulfonamide therapy the virulence of organisms is altered and the disease becomes insidious and slowly progresses; all clinical signs are masked until such time as pathology is obviously manifest.

It has been noted by Law[7] that detection of mastoid involvement by x-ray examination is definitely altered by the prior use of the drug. The remarkable absence of roentgenological evidence of mastoiditis, later proven incorrect at operation by the finding of overwhelming disease, is commonly observed. Also the presence or absence of recognizable x-ray signs varies with the variety of the drug employed. Dependence, therefore, on x-ray findings to clarify a picture confused by sulfonamides will be disappointing and will serve only to further delay necessary surgical intervention.

The cases that follow are representative ones of mastoiditis, sinus thrombosis, perisinal abscess, epidural abscess, meningitis and brain abscess. They are but an insignificant number of the many that are available. These cases are deliberately chosen from the services of several otologists in order to indicate the universality of such experiences rather than to limit them to those solely of the writer or of any one man.

REPORT OF CASES

CASE 1.—S. W., male, aged 10, was admitted to the service of Dr. Cunning at the Manhattan Ear and Throat Hospital. Six weeks previously, following the measles, the child developed a right otitis media. During the six weeks' interval sulfadiazine was administered irregularly and sporadically. There were periods when the child showed no clinical manifestations of disease and was well enough to attend school. It was not until two days before admission that an otologist was consulted and myringotomy advised. Pus was obtained on opening the middle ear. The first indication for hospitalization was drowsiness. Six hours after the child was admitted to the hospital, he became stuporous, unresponsive, and then comatose. On examination, the patient showed marked rigidity of the neck, positive Kernig sign, and

obvious signs of meningitis. The left ear was normal; the right ear showed an active, pulsating, rapidly reappearing discharge from the middle ear. Tenderness was difficult to elicit because of the patient's comatose condition. Spinal tap showed the fluid to be under a pressure of 300 mm., a 4 plus Pandy test, 1800 cells, 90 per cent polymorphonuclear cells. Hemolytic streptococcus was seen on smear and subsequently cultured.

An immediate mastoidectomy was performed under general anesthesia. Frank pus was obtained on elevating the cortex. The entire mastoid, which was very large, was completely destroyed. The lateral sinus was exposed by disease. Thick pus under pressure was found between the cortex and the lateral sinus, extending past the sinodural angle onto the epidural surface of the middle fossa. A huge epidural and perisinal abscess was uncovered. The sinus plate was uncapped from the jugular bulb to the post-sinus region. The plate of the middle fossa was removed, as was the bone in Troutman's triangle, until normal looking dura was exposed over the cerebrum and the cerebellum. There was extensive herniation of the dura with fullness which indicated investigation. An L-shaped incision of the dura of the middle fossa released 6 to 8 drams of non-odorous, thick yellow pus under tremendous pressure, mixed with spinal fluid. It was felt that this was a subdural abscess with rupture into the subarachnoid space. Two weeks after operation, the child showed evidences of a brain abscess, for which an exploratory operation was performed. A temporo-sphenoidal abscess was uncapped and a Mosher drain placed in situ. The child is progressing slowly, but well.

Comment. This case significantly illustrates: The unguided use of sulfadiazine; the progression of disease despite its use; the hidden advancement of mastoiditis, meningitis, and perisinal and epidural abscess before special otological opinion was deemed necessary; the increase in morbidity and possible mortality due to careless observation during the period of administration of the drug.

CASE 2.—G. B., a 4-year-old boy, had a discharge from the ear for three months. The child had been given "a new medicine" for many weeks after the onset of the discharge. The child was playful and active and attended kindergarten for short periods of time, only to be incapacitated again. This occurred repeatedly. Three days before admission there was a marked swelling behind the ear. On admission there were a foul-smelling discharge from a perforation in the anterior portion of the left drum, with marked postaural tenderness and swelling, drowsiness, paralysis of the left facial nerve, stiff-

ness of the neck and definite evidence of meningitis. Spinal tap showed 13,000 white blood cells; culture showed Bacillus coli. Blood culture showed a minute streptococcus haemolyticus. Simple mastoidectomy was done, and complete necrosis of the entire mastoid was observed. The dura was covered by a greenish-yellow exudate, which extended over the entire middle and posterior fossae. The child was given large doses of sulfanilamide and transfusions, but died of meningitis two days after the operation.

Comment. There was unquestionable alteration of the clinical picture by the prolonged use of sulfanilamide. Because of inadequate supervision in the use of the drug, a simple mastoiditis developed into meningitis, causing death.

CASE 3.—S. S., male, aged 79, presented himself at my office complaining of hoarseness of three weeks' duration. Routine examination of the ears showed the right ear drum to be dull, no landmarks visible, and marked hearing impairment by air conduction. There were no subjective complaints. The patient had had an otitis media about one month previously for which he was given small but sustained doses of sulfathiazole. The drug was discontinued and five days later, despite the absence of any subjective complaint, x-ray films of the mastoid were taken and showed unquestionable destruction. The story and the clinical picture indicated a pneumococcus, type III, infection. There was the slightest suggestion of tenderness of the tip, but this was difficult to evaluate in an old man who was hypersensitive. Mastoidectomy revealed a completely destroyed mastoid, exposure of the dura, and an epidural abscess from which was cultured pneumococcus, type III.

CASE 4.—W. O., male, aged 57, complained of pain in the ear following an acute upper respiratory infection. Myringotomy was performed five days later. The ear discharged for six days during which time the patient was given between 75 and 90 grains of sulfathiazole daily. The ear became dry, but the drug was continued for four more days. The ear remained dry for 24 days, then a sudden discharge occurred which brought the patient to my office. Examination showed a very slight, stringy, mucoid discharge from the middle ear. The drum was thickened and no landmarks were visible. The patient had no fever. There was a very slight headache over the temporal region, with a suggestion of mastoid tenderness. Hearing was markedly impaired and the patient noted a persistent, low-pitched tinnitus. Culture of the pus of the middle ear showed Staphylococcus aureus. The clinical picture was so typical of a pneumococcal mas-

toiditis that mastoidectomy was advised immediately. X-ray films made of the mastoid before operation were not significantly positive to aid the clinical diagnosis. Mastoidectomy showed a completely destroyed mastoid, with an epidural and perisinal abscess. A specimen taken at operation for cultures revealed pneumococcus, type III.

CASE 5.—F. S., female, aged 5, developed a pain in the ear following an acute upper respiratory infection. She was immediately given 60 grains of sulfathiazole daily for ten days. The temperature returned to normal, and the child went back to school. Aside from a moderate amount of sluggishness the child was apparently happy and playful. The pain recurred two weeks later, and the patient was referred to me. The clinical findings were so slight that the referring physician had suggested that there was no hurry and that I might see her at my leisure. Immediate examination, however, showed the left drum to be thick and dull, no landmarks visible, hearing markedly impaired, no fever. There was slight but definite tenderness over the mastoid antrum. X-ray examination confirmed the clinical impression of an acute mastoiditis. A mastoidectomy, performed the next day, showed the entire mastoid to be destroyed, with exposure of the sinus by disease in the region of the tip. Pneumococcus, type III, was cultured from the mastoid.

Comment. Cases 3, 4 and 5 illustrate the progress of disease from acute otitis media to mastoiditis, epidural abscess and involvement of the lateral sinus, despite sulfonamide therapy in the early stages of infection. The combination of the insidiousness of pneumococcus, type III, and the masking effect of sulfonamides leads to the absence and obscurity of all clinical signs of mastoid involvement and its complications.

CASE 6.—B. S., male, seven years old, complained of pain in both ears and was given 80 grains of sulfanilamide daily for two weeks. Because of a rash attributed to the drug, this was stopped. The middle ear infection resolved entirely in two weeks. Four weeks later, the child developed a temperature of 102°F. though he had but little pain in the ear. There was a bulging left drum, with slight discharge from an anterior performation from which pneumococcus, type III, was cultured. Two days later, the child was admitted to the hospital with a temperature of 103°F. complaining of hemicranial pain. The mastoid was tender. X-ray examination of the left mastoid showed evidence of a destructive process. Mastoidectomy showed an extremely diseased mastoid, with a large perisinal abscess and a suppurative sinus,

and thrombophlebitis. The sinus was completely obliterated. There was no bleeding from the jugular bulb, the jugular vein having been ligated.

Comment. This case reveals another type of pathological involvement brought on by the progression of disease from a mastoiditis, which was not observed during the course of sulfonamide therapy.

CASE 7.—T. A., a 10-year-old girl, had scarlet fever. Acute otitis media developed and a myringotomy was performed. The ear drained continuously and profusely. The area over the mastoid was not tender. The patient had been given sulfanilamide for thirty days, about 20 to 30 grains (1.3 to 1.9 Gm.) per day, with no cessation of the aural discharge. For one month there was no headache or postauricular pain. When first seen, the child had a temperature of 99.5°F. and was comfortable. Vague temporal headache had occurred the day before. There were slight postauricular tenderness and a profuse discharge. The administration of sulfanilamide was stopped, and the next day the temperature rose to 102°F. The child became restless and the headache became marked. Postauricular tenderness was definitely increased. Simple mastoidectomy revealed extensive disease everywhere in the mastoid, with complete destruction of the zygoma and the tip. Culture of material removed at operation revealed Streptococcus haemolyticus beta.

Comment. Sulfanilamide was given early in acute otitis media. Definite progression to coalescent mastoiditis occurred despite the drug. Headache, fever and other clinical evidence were absent, despite marked destruction of the mastoid.

Twenty-four hours after the sulfanilamide was stopped, fever, headache and postauricular tenderness appeared, the masking effect of the drug having been removed.

The uneffectiveness of the drug in the presence of a suppurative focus and its capacity to attenuate the course of disease without preventing its progression were demonstrated.

CASE 8.—J. L., a woman 22 years of age, had an infection of the upper part of the respiratory tract two weeks before her admission to the hospital. Four days before admission pain in the left ear developed, and a myringotomy was performed the next day. For two days before admission she had been dizzy; the type of vertigo was not carefully described. The temperature ranged between 100°F. and 102°F.; she did not have chills or convulsions, but she did have marked parietal headache. Ten days after admission signs of acute

mastoiditis developed, and simple mastoidectomy was performed on the left under general anesthesia. The mastoid was large, with no destruction of the intercellular septums. Each cell contained thin pus, from which Streptococcus haemolyticus beta was subsequently cultured.

After operation, the patient had a sustained febrile reaction, which could not be accounted for by the local aural condition. Fifteen days after operation she began to complain of pain over the left eye, and at this time the possibility of suppuration of the petrous pyramid was thought of. Examination of the nose and paranasal sinuses did not reveal anything at this time. Twenty days after the original mastoidectomy, the wound was revised and the petrous pyramid was investigated. Granulations were removed from the plate of the sinus and that of the middle fossa. No tract was visible in or around the semicircular canal. The squama was removed and the dura of the middle fossa elevated from the superior surface of the petrous pyramid. This was done with ease because a large amount of fluid was removed by spinal tap prior to operation. A large gush of nonodorous, thick creamy pus was obtained from a pit about ½ in. (1.3 cm.) anterior to the arcuate eminence. A rubber drain was inserted and the wound closed. Culture of the pus showed Streptococcus haemolyticus.

The patient received repeated transfusions. Lumbar puncture, performed five days later because of headache and some rigidity of the neck, revealed evidence of meningitis; the fluid contained 4,500 cells,, 80 per cent polymorphonuclears and 20 per cent lymphocytes, and yielded no organisms on smear. At this time, one month after the original mastoidectomy, the possibility of an abscess of the brain was considered, but no localized signs were found. Repeated spinal taps were done. The patient was given large doses of sulfanilamide the hemoglobin was watched and the sulfanilamide content of the blood and the spinal fluid determined at regular intervals. About 40 days after the original operation it was first noticed that anomia and a few vague changes in the deep and superficial reflexes had developed. Blood cultures were repeatedly negative.

At this time an abscess of the brain, loculated meningitis and otitic hydrocephalus were all considered, but no definite diagnosis could be made. Because of the persistence of the findings in the spinal fluid, the wound was reinvestigated. The dura was covered by a thick yellow exudate, and on elevation of the dura of the middle fossa again a gush of thick creamy pus appeared. Loculated pockets were not found.

Because of the persistence of fever, the findings in the spinal fluid, repeated attacks of vomiting and transient anomia, an exploratory craniotomy for an abscess of the left temporal lobe of the brain was performed eight days after the re-exploration of the petrous pyramid. Aspiration in several directions in the temporal lobe failed to show any pus. The dura was incised and it was noted that the brain had a peculiar yellow discoloration, but no pus was found.

After the craniotomy the patient's condition was about the same. Ten days later when the wound was dressed the probe fell into a cavity in the temporal lobe. A few ounces of thick pus escaped.

After drainage of this abscess cavity, the patient's condition progressively improved; the neurologic symptoms gradually subsided, and except for the peculiar mental changes, the patient appeared to be getting well. Gradually thereafter, the spinal fluid became clear, the mental state returned to normal, the temprature became normal, and the patient progressed to an uneventful recovery with no sequelae other than some diminution in hearing.

Comment. The patient had acute mastoiditis complicated by suppurative petrositis, streptococcocic meningitis and an abscess of the temporal lobe.

The clinical picture of otitic meningitis was masked by the use of sulfanilamide. On a number of occasions except for a moderate fever the patient was symptom free. Physical signs were absent, and yet spinal tap gave definite evidence of meningitis, that is, an increase in cells and streptococci.

Until the otitic focus was adequately dealt with, sulfanilamide only partially controlled the meningitis.

The course (two and one-half months) of meningitis was prolonged under administration of sulfanilamide.

CASE 9.—D. Y. gave a history of pain in the left ear followed one week later by a myringotomy; Streptococcus haemolyticus was obtained from the ear. A thin pulsating discharge continued for the next three weeks. Hearing was impaired, and the nasal sinuses were clear. The patient was given 10 grains (0.65 Gm.) of sulfanilamide every four hours for ten days, with cessation of all symptoms. Twenty-two days after the onset of the infection, nystagmus developed to the right and left, more marked to the left. This continued unabated and was associated with supra-orbital headache. The middle ear showed evidence of resolution up to the day before operation, at

which time the ear drum became full and the middle ear began to discharge. On pressure over the mastoid, the patient complained of slight soreness but no actual pain. The sulfanilamide was stopped. A left mastoidectomy was performed and there was marked destruction of the mastoid; the dura was covered with fine granulations. The possibility of petrositis was entertained because of nocturnal pain, slight postauricular tenderness, thick discharge, slight fever and nystagmus directed to the diseased ear. The patient made a complete recovery.

Comment. The clinical picture was masked by sulfanilamide, presenting a low temperature, absence of pain, evidence of resolution of the middle ear without signs of mastoid involvement. Petrositis was the first indication of an otitic complication without apparent postauricular disease.

CASE 10.—E. T., aged 20, was admitted to the service of Dr. Cunning, with a story of acute middle ear infection following an acute upper respiratory infection. Twenty-four days before admission he complained of pain in the left ear. The physician who first saw him noted no discharge from the ear and immediately placed the patient on sulfadiazine. The patient was given the drug for 14 days, and then noted an inability to move the left side of the face. Despite this, the patient was able to go to work and had relatively little pain. There was a profuse discharge from the middle ear. On admission, he had complete peripheral facial paralysis, and a subperiosteal abscess. Immediate mastoidectomy revealed a completely destroyed mastoid, with exposure of the facial nerve at the beginning of the descending portion, and exposure of the lateral sinus by disease. The patient is now recovering. The facial muscles can be moved, and there is a response to faradic current.

Comment. This case significantly illustrates: the progress of disease, as indicated by the beginning of the discharge four days after the beginning of sulfonamide therapy; the progress from a simple mastoiditis to one involving the lateral sinus wall and the facial nerve; the increased morbidity and the possibility of social stigma by disfigurement, which would have been avoided had surgery been performed earlier and its need not been masked by sulfonamide therapy.

CONCLUSION

Reiteration must be made of the remarkable value of sulfonamide therapy for acute otitis media when consistent follow-up of the infection is made. The drug must be continued in adequate doses after

the infection has apparently subsided and the patient kept under observation despite his return to normalcy.

The abuse of a blessing must be emphasized and re-emphasized so that the general practitioner will be aware of the fact that disease can progress in the absence of all clinical signs or symptoms, and that relatively slight otological findings may be an indication of disease far beyond that suggested by such findings.

It is a further hope that those who use the drug with comparative freedom will realize that the results of the use of a sulfonamide may be infinitely more dangerous than the primary disease for which it was originally intended. Extremely careful observation during the administration of the drug enhances its value. It is a serious mistake to believe that the sulfonamides are a panacea and lessen the need for meticulous clinical supervision.

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LX

SYNDROME OF GARCIN—UNILATERAL TOTAL INVOLVEMENT OF THE CRANIAL NERVES WITH REPORT OF ONE CASE

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In 1927 Garcin[1] described the syndrome of unilateral involvement of all, or nearly all, the cranial nerves, associated with tumors of the nasopharynx and the base of the skull. Three criteria were elaborated by Garcin for the diagnosis of this syndrome:

1. Unilateral involvement of all the cranial nerves.

2. Absence of any signs of involvement of the brain proper, that is, absence of motor or sensory or other signs and symptoms of affection of the brain.

3. Absence of any sign of increased intracranial pressure, namely, papilledema, spinal fluid changes.

Two conditions—both neoplastic—may be the cause of this condition: either a primary sarcoma of the base of the skull and the meninges, or a primary neoplasm of the nasopharynx extending into the cranial cavity. Garcin felt that the chronology of the signs and symptoms together with biopsy material could aid materially in the differential diagnosis of these two conditions. In two cases reported by Davison and Kahr[2] the initial symptoms pertained to the nasopharynx. However, it does not follow that the chronology of the signs and symptoms will always lead to a correct diagnosis because in some cases the tumor of the nasopharynx is silent and is only recognized after the cranial nerves are encroached upon.

The clear-cut picture drawn by Garcin may be further modified. If the patient lives long enough, it is possible that the tumor will encroach upon the brain and give rise to cerebral signs and symptoms. In one of Davison's and Kahr's cases[2], the patient had bilateral pyra-

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midal tract signs. In our own case the patient ultimately developed an Oppenheim reflex on one side. The discrepancy, however, between the primary massive cranial nerve involvement and the minimal tract involvement as well as the late appearance of the cerebral signs points away from primary disease of the brain stem.

Other lesions to be considered are adenopathies, trauma to the base of the skull, syphilitic meningitis, brain stem lesions and cerebral polyneuritis. In general, the differential diagnosis rests upon the fact that none of these conditions fulfills the criteria previously mentioned. In particular, the strict unilaterality is but rarely observed in those conditions although local adenopathies (inflammatory or neoplastic) and trauma (bullet wounds) may produce unilateral cranial nerve signs. However, they are not likely to cause total involvement of the cranial nerves on one side but rather regional groupings, such as are seen in the syndromes of Villaret, Collet, Vernet, and others. Syphilitic meningitis may cause unilateral involvement, but here too, it is apt to be limited to a few cranial nerves, and there frequently is evidence of long tract involvement. Cranial polyneuritis generally is bilateral. Other basal tumors, such as chordomas, affect the cranial nerves bilaterally and may give rise to signs of increased pressure as reported by Friedman and Stevenson[3].

The strict adherence to the three criteria of total, unilateral cranial nerve involvement, absence of long tract signs, and absence of signs of increased intracranial pressure reduces the diagnostic possibilities to primary sarcoma of the base of the skull and intracranial extension of a primary neoplasm of the nasopharynx.

REPORT OF A CASE

The patient, a 56-year-old white male, was admitted to the neurological service of the Brooklyn Jewish Hospital on December 10, 1940, with complaints of numbness of the face of two years' duration and blindness of the right eye of six weeks' duration. Two teeth of the right upper jaw had been extracted under local anesthesia two years before admission. Two months later he developed numbness of the right side of the upper lip which gradually spread and within one year involved the entire right side of the face, from the mandible to the mid-scalp region and to the tragus. At the same time numbness and loss of taste over the right side of the tongue and right side of the oral cavity appeared. He preferred to chew with the left side. A year prior to admission to the Brooklyn Jewish Hospital he developed

complete ptosis of the right eyelid which gradually lifted up in six months. He noticed that this was due to progressive bulging of the right eyeball. At that time he was able to see with his right eye, although vision was blurred. For the last six weeks he had been completely blind on the right and unable to move his right eye. Six weeks ago the hearing in his right ear became diminished. He had no headache, nausea, vomiting or tinnitus and only transient vertigo. His general health and strength remained unchanged; there was no loss of weight.

Several examinations at the Brooklyn Jewish Hospital revealed: An elderly individual, slightly obese, apparently in good health, who exhibited definite personality changes bordering euphoria. He had bilateral reducible hernias, an emphysematous chest, a few fine râles at both bases and a slightly enlarged heart.

Neurological examination revealed: Right dacryocystitis and conjunctivitis, proptosis of the right eye, pallor of both optic discs, and paralysis of the third, fourth, fifth, sixth, seventh, and eighth nerves on the right side, weakness of the right twelfth nerve. The left knee jerk was overactive, the left plantar reflex diminished.

The urine was normal; the blood count showed a moderate leukocytosis. The blood chemistry was normal, the blood and spinal fluid serology were negative, spinal fluid manometrics were normal, the Ayala index was 7.4, the spinal fluid protein was 73.5 mg. per 100 cc. The roentgenograms of the skull indicated a tumor in the right half of the base of the skull. Laminography revealed a defect in the right cribriform plate and a blurring of the structure of the orbit and anterior clinoid process on the right, suggesting a destructive lesion.

A craniotomy was performed on Dec. 30, 1940. A grayish tumor was found on the right side in the anterior and middle fossae. It was removed piecemeal; it was hard, elastic and rubbery, adherent to the base of the skull but not to the overlying brain.

The pathological report of the operative specimen was metastatic carcinoma. Attempts were made at finding the primary site of this neoplasm. X-ray films of the chest were negative for any primary or metastatic carcinoma. Ear, nose and throat examination, including nasopharyngoscopy and x-ray films of the paranasal sinuses, failed to reveal any neoplasm. Repeated gastro-intestinal series showed the duodenal bulb to be constantly deformed and irregular, suggesting a chronic or long-standing duodenal ulcer.

Fig. 1.—Showing tumor tissue on the under surface of the dura.

The patient was admitted to the surgical division of the Montefiore Hospital on January 26, 1942.

Neurological examination at this time showed that now all the cranial nerves on the right side were involved except the seventh. An Oppenheim sign was elicited on the left, vibration was impaired up to the iliac crests.

Roentgenogram of the spine showed some irregularity of the body of the twelfth vertebra. This picture was suggestive of metastatic involvement. Roentgenograms of the paranasal sinuses showed a haziness in the outline of the lateral wall of the right antrum. Slight haziness of the left frontal sinus was present.

The patient went gradually downhill and died on June 10, 1942.

Complete necropsy revealed the following: The mouth showed evidence of a previous Caldwell-Luc operation on the right side and tumor tissue was obtained from the antrum. The examination of the brain in situ showed a sheet-like mass of tumor tissue extending from the anterior to the posterior fossa. Though the tumor was predominantly on the right side some of it had crossed the midline. In addition to the sheet-like mass, isolated nodules attached to the inner surface of the dura were also found. All the cranial nerves on the right

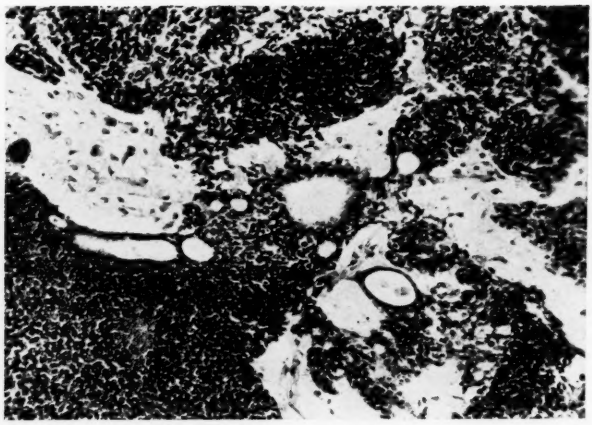

Fig. 2.—Photo micrograph of tumor, showing closely packed tumor cells and cyst-like spaces formed by them.

side were atrophied and discolored; those on the left appeared normal. Marked destruction of the sella turcica had occurred and no pituitary body was seen.

Metastases to the liver, adrenals, pleurae and vertebrae were found.

The tumor consisted of highly variable columns of cells widely separated by a vascular, edematous stroma. The columns of tumor cells contained cyst-like spaces of variable size. The tumor cells were small, closely packed, with very little cytoplasm and relatively small dark vesicular nuclei. Mitoses were not seen. The diagnosis was epithelioma adenoides cysticum, probably arising in the right maxillary sinus.

COMMENT

From the pathological report and the fact that an operation had been performed on the right maxillary sinus, it is apparent that the tumor had secondarily invaded the base of the skull. Despite the precise history taken at two hospitals this point was missed, and despite a careful radiological search for a tumor of the nasopharynx no mass was found during the lifetime of the patient.

The case is a good example of the syndrome first described by Garcin. The three conditions of unilateral global involvement of the

cranial nerves, the absence of signs of increased intracranial pressure and the absence of signs of long tract involvement are well fulfilled in this case. The pyramidal tract damage as shown by the Oppenheim reflex on the left side was trifling in contrast to the massive cranial nerve involvement. The absence of seventh nerve signs despite anatomical evidence of its involvement is puzzling.

Of greater interest is the apparently complete destruction of the pituitary gland without clinical evidence of pituitary dysfunction. In three of the cases described by Garcin, destruction of the pituitary gland without clinical evidence of pituitary dysfunction was also found. Needles[4] remarks that he has found, in cases of basal tumors having their origin in the paranasal sinuses, extensive destruction of the pituitary gland without clinical signs.

The clinical picture while the patient was in both hospitals was one of neurological involvement and, except for a haziness of the lateral outline of the right maxillary sinus, there was nothing to suggest a nasopharyngeal lesion. Even if the operation on the right maxillary sinus had been considered, the neurological picture was still predominant. The first symptom was involvement of the fifth nerve. This merely confirms the fact that nasopharyngeal tumors may first give evidence of their existence by neural signs. The unsuccessful search for a nasopharyngeal tumor naturally led to the suspicion of metastatic involvement. At that time we were not acquainted with the syndrome of Garcin. Had we been, we would have been more impressed with the strict unilaterality of the signs, the absence of increased pressure and the absence of long tract signs.

SUMMARY

The syndrome of Garcin is described and a new case is added. The criteria for its diagnosis are described and the differential diagnosis is discussed. It is noted that several cases of nasopharyngeal tumors penetrating the cranial cavity have apparently destroyed the pituitary gland completely without any obvious clinical signs of pituitary insufficiency.

We wish to thank Dr. Davidoff for giving us a complete record of his findings.

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Special Articles

The following paper "The Cigarette Habit" by the late Dr. J. C. Mulhall is reprinted from the Transactions of the American Laryngological Association of 1895 because of its timely interest and its colorful exposition of the attitude of fifty years ago toward cigarettes and cigarette smokers. The participants in the discussion were the outstanding laryngologists of the day.

Dr. Mulhall was a distinguished St. Louisan. "His personality," says his biographer, "was conspicuous. Gifted by nature with a keen mind and tongue, ready with wit, repartee and, if need be, sarcasm, with abundant common sense and a cheerful disposition he combined all the essentials to qualify as a man among men."

This paper of Dr. Mulhall and the comment which it aroused bring out some very astute observations flavored, as they inevitably would be, with the prejudices of the times.

Dr. Langmaid, the chief critic, a Bostonian of national reputation, had been President of the Association in 1891. A non-smoker, he lived to the ripe age of 77 and we are told by his biographer that "in the course of his life he became a member of many musical associations, the Chickering Club, the Parker Club, the Boylston Club and later the Apollo Club and the Cecilia. Of his various interests perhaps the one nearest to his heart, outside of medicine, was the Harvard Musical Association, of which he was president for many years. He was also a director of the New England Conservatory of Music. For a quarter of a century he sang tenor in the quartette at Trinity Church before the establishment of the vested choir."

Nine years later Langmaid himself read a paper, "The Effects of Tobacco on the Throat," which is likewise reproduced here with the discussions. These two contributions, pro and con, divorced as they are by forty years from the disturbing atmosphere of brand exploitation, and antedating that gigantic clinical demonstration afforded by the almost universal cigarette habit of today—a habit "dignified if not sanctified" in the last war—might have been written by one of our contemporaries. And why not? Membranes have not changed, tobacco is much the same despite the propagandists, and wits were if anything keener than ours as the accompanying papers amply demonstrate.—Ed.

LXI

THE CIGARETTE HABIT

J. C. MULHALL, M. D.

Reprinted from the Transactions of The American Laryngological Association, Volume XVII, Page 192, 1895

As a member of this and the Climatological Association, and as one who has smoked cigarettes for twenty-five years, I feel that I may speak with a certain amount of authority on this subject. "You, a throat doctor, and smoke cigarettes!" is a phrase that has finally wearied my ears; and, bubbling with mild wrath, "I rise to explain."

The pleasure and the penalty of this vice have never been rationally described, to my knowledge, other than by myself. This I did in a paper published in the *St. Louis Courier of Medicine* some eight years ago, and so little notice was given it that what I now say will be practically new.

A word as to the tobacco habit in general. Mankind pursues various methods in using it: by chewing it, by dipping, by cigar or pipe, by snuffing and by cigarettes There is a reason why each one pursues a particular plan. Early associations have much to do with the selection of the plan; but, apart from this, each method has its own particular pleasure. The man who both chews and smokes derives a different kind of satisfaction from each method, and he would derive a still different kind did he take snuff. Cigarette smokers may be divided into those who inhale the smoke and those who do not. The latter class is a very small one and the pleasure is the same, in a milder degree, as that of the cigar and pipe smoker, wherein the smoke chamber is the mouth. But all real devotees of the cigarette inhale. That is, with a quick inspiratory act, the smoke is drawn through the larynx into the trachea and, so far as I have been able by different experiments to learn, into the first division of the bronchial tubes; not, as the public believes, into the lungs proper. These inspirations are nearly always superficial, and the fact alone that there is a tidal and residual air would teach that the smoke does not reach beyond the bronchial tubes. Inhalation explains the pleasure of cigarette smoking. If the cigarette smoker did not *feel* the smoke in his larynx and windpipe, his pleasure would be gone. Every old cigarette inhaler will tell you this fact: that if he perchance smokes a brand of cigarette very much milder than that to which he has been accustomed, he will at once reject it, simply for the reason that larynx and trachea have been accustomed to a certain degree of irritation. The larynx and trachea

have, so to speak, acquired a habit which rejects any unusual departure. For the same reason the inhaler rejects a brand of cigarettes much stronger than that to which he is accustomed, nor will he inhale the smoke of a cigar—vastly more irritating than that of any cigarette. The inhaler may change his cigarette for one more pleasing to his sense of flavor, provided always, however, that it satisfies his accustomed degree of laryngeal and tracheal irritation.

The pleasure in cigarette smoking, therefore, as compared with other tobacco habits, may be said to be a pleasurable irritation of the laryngeal and tracheal sensory branches of the pneumogastric nerve.

Another question frequently hurled at me in all these years has been, "What satisfaction can you get out of those weak little things?" The question means nicotine satisfaction. I once more rise to explain.

One absorbs nicotine in accordance with the amount of absorbent surface in contact with the column of smoke. In ordinary smoking the mouth alone is the smoke chamber; but when one inhales, one must add to the mouth the mucous membrane of the larynx, windpipe, and larger bronchi. There is, hence, roughly speaking, three times as much surface for the absorption of nicotine; and consequently, though a cigar contains vastly more nicotine, three-fourths of it is wasted, so far as the question of nicotine intoxication is concerned, as compared with the cigarette. Moreover, the cigarette smoker consumes two or three while the cigar smoker consumes one. The puny cigarette is, therefore, not so weak as it appears, and with this explanation begins to appear worthy of the newspaper term "deadly." Again, the cigar smoker, as compared with the cigarette smoker, is an infrequent consumer. We know that, with most drugs, if we divide an ordinary dose into ten equal parts and give one part every ten minutes until the ten parts are taken, we get a more powerful effect than if the whole were given at one dose. So it is with cigarettes. The dose of nicotine is smaller, but the doses are much more frequently repeated. I can smoke one large, strong cigar in the ordinary manner without evidence of nicotine intoxication, but I can not smoke three cigarettes inhaled, in succession, without nausea or vertigo or a rapid pulse.

The evil effects of cigarette smoking may be divided into the local and constitutional. As compared with other tobacco habits, if the cigarette were composed of other ingredients than tobacco and paper, we should, as clinicians, be prepared to look for different signs and symptoms. So far as the constitutional effects are concerned, I wish to state, as one who has carefully watched this question for fif-

teen years, that they are absolutely the same as those of tobacco used in any other form. The evil symptoms are always those of nicotine poisoning—not those of any other drug. The only chemist of high standing who, to my knowledge, has analyzed cigarettes is Dr. Ledaux, who last winter presented to the Section in Jurisprudence of the New York Academy of Medicine a report of the analysis of several popular brands of cigarettes. The dealers from whom he obtained the samples expressed their hope to him that he might find all kinds of narcotics in them. They explained that handling them was a nuisance to them; that all the profit accrued to the cigarette trust. He found absolutely no evidence of any other drug but nicotine in the tobacco, and in the paper a harmless quantity of cellulose.

The W. C. T. U. has endeavored to crush the cigarette evil by asserting that opium, *cannabis indica,* and other narcotics were present in cigarettes. Vice can not be cured by misrepresentation. The only narcotic present is nicotine, and this is an evil or not according to a great many different circumstances. That chief circumstance when, without exception, it is always productive of great harm, is youth. Every medical man will admit, theoretically, that this should be a fact, and the few who, like myself, have made practical observations will tell you that they never saw a child (I mean by this term those who have not reached puberty) who used tobacco habitually whose health was not in some manner badly impaired. What else would one expect the tender, growing nervous organism to do but wilt under the steady daily influence of a drug like nicotine? In adolescence—and practically this may be said to be from puberty until eighteen in females and twenty-one in males—the evil is not so great, but is still a great one; for, though the nervous crisis of puberty has been passed, the nervous system is still rapidly developing. The nerves are more resistant than in childhood, but, on the other hand, greater demands are correspondingly made upon them, either by the higher phases of education in one class or by the actual daily struggle for existence in the other. That the use of tobacco is a serious handicap in adolescence is proved by the investigations of others than myself. At several of our great universities it has been found by exact and scientific investigation that the percentage of winners in intellectual and athletic contests is considerably higher in the total abstainers from tobacco. Sammy, the best known newsboy of St. Louis, who by his wit and energy at the age of fourteen has accumulated quite a bank account, at my instigation made a series of unbiased observations concerning the newsboys of St. Louis. He found, other things being equal, that the selling capacity of the boy who used no tobacco was

much greater than that of the boy who used tobacco either by chewing or by smoking.

It being admitted that the use of tobacco is a great evil in the young, it follows as a self-evident proposition that any method which encourages its use must be more reprehensible than a method which discourages its use, and the cigarette above all other methods presents this encouragement to the use of tobacco. In its mildness is concealed its very capacity for doing harm, for the reason that it teaches the use of tobacco. Every one knows the picture by Brown of a newsboy clinging to a lamp-post, limp, pallid, and vomiting, entitled "His First Cigar." Had it been his first cigarette the picture would not have been true to Nature, for, unfortunately for our growing youth, the first cigarette does not induce this deathly nausea. Were this only the case there would be but one cigarette smoker in youth where there are now a hundred. The boy at first uses only the mouth as a smoke chamber, and as a cigarette is so mild he absorbs but a minute quantity of nicotine, insufficient for nausea. He gradually becomes able to consume more cigarettes, and quickly acquires nicotine tolerance. He is not allowed to pursue this method long. Invariably some other boy teaches him to inhale. At first it causes violent cough and many would never repeat the attempt, but the taunts of the other boy are heard, and with the bravado of boyhood he perseveres. The larynx and windpipe soon tolerate the smoke, then demand it, and the boy is a full-fledged cigarette fiend.

The mildness of the cigarette explains also its fast-spreading use among young women, especially the leisure-class young ladies. As a rule they do not inhale, for at the first attempt the violent cough ensuing quenches ambition in this direction, and, unlike the youth or the boy, she is seldom encouraged to persevere. The fear of a tobacco-tainted breath also curbs her habit. In young ladies who smoke cigarettes very moderately and who do not inhale I have never seen evidences of nicotine poisoning. Their immoderate use, even without inhalation, may, of course, afford sufficient nicotine to disturb the health. Apart from this, however, I join hands with the ladies of the W. C. T. U., who in New England have established anti-cigarette leagues among young ladies reformed of the habit, because of the pernicious example these young ladies may set to the youth and childhood which surround them.

Personally I may add that when I am appealed to on the same ground I freely admit the force of the argument. I, however, do not pose as a reformer or advocate, only as an expert.

The great evil of tobacco is its constitutional effect on the nervous system. The much lesser evil is local—namely, on the upper respiratory organs. My experiece, like that of Morell Mackenzie, is that, provided there is no other factor, the use of tobacco provokes little or no disturbance to these organs. That it may aggravate a throat or nose trouble occasioned by other causes I will admit, or that by its constitutional depressing effect it may aggravate such trouble I will also admit; but, excluding all other causes and looking at tobacco purely in respect of its local effect, I must deny that it ever causes, as ordinarily used, throat disease worthy of the name. There are a few exceptions as there are to all laws in medicine. There are idiosyncrasies in regard to the use of tobacco, both with reference to the throat and the nervous system. They are rare. Tobacco, in its ordinary use, at most produces a slight hyperæmia or insignificant catarrh in the healthy throat. As used in cigarettes—that is, by inhalation—the smoke comes in contact with the laryngeal, tracheal, and bronchial mucous membrane, and here produces in many the same trivial hyperæmia and secretion. This latter is pearly and is ejected with a single gentle cough. I am unaware that I have this slight cough unless reminded by others. I have occasionally heard whistling râles in the bronchi of those who inhale very deeply and are immoderate smokers. Hyperæmia, not inflammation acute or chronic, is the sole disturbance. The effects in the larynx of the ordinary healthy man seem almost nil. Mario, the great tenor, inhaled cigarette smoke between the acts. I experience no vocal difficulty in delivering lectures. Maxwell, the murderer of Preller, was confined in the St. Louis jail for two years, during which time he inhaled an average of forty cigarettes a day. I secured the larynx and trachea of Maxwell, but could discover no evidence of morbid change other than a fracture of the hyoid bone caused by the hangman's rope.

Twenty years ago in this country this habit existed, but was unusual, probably because each consumer was compelled to make his own cigarettes. But since the American manufacturer with his advertising genius has scattered them over this country, ready made and very cheap, the habit has grown enormously. Nervous diseases and insanity are rapidly increasing in the American people we are assured by our own neurologists. Our nation was already noted as furnishing proportionately more neurasthenics than any other. If to such an inheritance American youth then adds the nerve-destroying nicotine habit which the cigarette so materially assists in spreading, there is grave reason to hope that the cry of reform may be echoed and re-echoed throughout our glorious country. There is no such instructor of the public as the press, and I trust that our newspapers will publish

broadcast such information as this and kindred essays may give them on what is fast becoming a national vice in American youth—the cigarette habit.

DISCUSSION

Dr. Ingals said it was most fortunate that such an old cigarette smoker was alive to tell this tale, and was willing to tell us in just what respect cigarette smoking was objectionable. It was well that people should understand the difference in the effect produced by smoking cigars and by smoking cigarettes. He was sorry that the author of this admirable paper should have made the grave mistake in the latter part of his paper of intimating that tobacco smoking did no harm. He thought that all the members had seen chronic pharyngitis and irritable conditions of the fauces which were apparently due to smoking. Personally, he had seen many persons whose nervous systems had been seriously affected by indulgence in tobacco. The author had stated that the local effect was slight, and this was probably true in the majority of cases but not in the large minority.

Dr. Carl Seiler said that Dr. Ingals spoke without experience as a smoker, and hence he could hardly enlighten us much on this subject. The speaker said he was himself a smoker, and he had never seen a case in which any local effect had been produced by smoking, except in those American smokers who did not know how to smoke, and who were continually expectorating, thus producing an abnormal dryness of the pharyngeal mucous membrane. The smoke of a cigar or pipe, if not inhaled, remained in the mouth, a part of which was covered with tessellated epithelium, and not with columnar epithelium.

Dr. Daly said that he had begun smoking when he was about seven or eight years of age, and had smoked ever since then, for the most part, temperately. He had always experienced a sense of great depression, except when he had smoked after taking some stimulant or a hearty meal.

Dr. Langmaid said that he had understood the reader of the paper to say that there was but little irritation of the pharynx and larynx as a result of cigarette smoking. He recalled a stalwart Irishman whom he had seen in his office. An examination of the throat had led him, in spite of the man's nationality, to express the opinion that the patient was not a smoker, and the man had admitted that such was the case. He had known this by the coloring of the mucous membrane of the pharynx and larynx. If this observation had been correct, and not simply a shrewd guess, it was evident that there was a decided local effect upon the mucous membrane. He thought that all would admit that the female throat was ordinarily less hyperæmic than the male throat—at any rate, this was particularly noticeable in singers. During the past winter he had had occasion to treat a physician with a very irritable throat. While the associated mental disturbance and other symptoms were not to be attributed to the use of tobacco, he had been forced to the conclusion, as the patient also had been, that the smoking was responsible for most of the trouble. He could invariably tell from an examination of that man's throat when he had refrained from smoking for a few days.

From a large personal experience in the treatment of prominent singers, he had found that smoking exercised a potent influence on the voice. In his own case, he had learned that, in order to be in good voice, he must not smoke during the

day if he was to sing that evening. Because one prominent singer could smoke and sing, this was no argument that others could do so. The best singers of today underwent a great deal of fatigue. He had in mind one singer with a magnificent voice, in whom he felt sure he could detect the effect of cigarette smoking. He had known another singer, an inveterate smoker, who had found it necessary to abstain as long as three weeks at a time from smoking, in order that he might be at his best for some great effort in singing. He would say that the bad effect on the pharyngeal mucous membrane was much less than cigarette smoking than from pipe smoking, for the reason that the smoke was not so hot. What he objected to in cigarette smoking was its destructive effect upon consecutive thought. The cigar smoker did not want to be narcotized; the cigarette smoker did want this.

Dr. Simpson related his personal experience with regard to smoking and its local effect upon the singing voice. The reader of the paper had spoken very pertinently when he had said that it was in the allied conditions that the local effect of smoking was increased. At one time he had given up smoking absolutely for eight years, and passed through what seemed to be similar to the experience of the opium smoker in his attempt to give up his habit. During this period when he was not smoking, his throat had been free from any discharge or uncomfortable sensation, and he had been able to use his voice with remarkable ease. After he had resumed smoking he had found it much more difficult to keep the singing voice in good order. The barytone did not suffer so much as the tenor voice did from smoking. He also felt that he could detect a smoker's throat by its appearance.

Dr. Newcomb thought there was a certain amount of habit about smoking, independently of the effect of the tobacco itself. Those who had looked into the literature of pharyngeal mycosis know that all writers alluded to the possible good effect of tobacco in that condition. He now had under his care a young Swedish woman of splendid physique, and without any bodily disturbance except a pharyngeal mycosis. She had been treated with the cautery, but without much benefit. She had then been lost sight of for a time, and on her return had been decidedly improved. She had finally admitted that during this time, on her own responsibility, she had been smoking Monopole cigarettes without inhaling the smoke. It seemed that in this case, at least, the smoking should be given a large share of the credit for her improvement.

Dr. Langmaid said that he had once tried the use of a solution of nicotine in a case of this kind, and with a most disastrous result. The application had been followed by immediate and severe syncope. He wished to warn against this, although it had been recommended.

Dr. Swain said that an interesting fact brought out by certain measurements taken in the colleges relative to the physical development of the students, had been that among tobacco smokers, as a class, there was a smaller chest expansion than among other students.

Dr. Longman remarked that this paper filled a hiatus in medical literature—*i. e.*, the description of diseases by physicians affected with them. There was altogether too little of this in our medical books. It had occurred to him during the discussion that possibly the irritation observed by Dr. Langmaid in singers might have been due to many of the slight causes well known to affect the throats of

singers. Some well-known singers could not expose themselves to the air while riding—was this an argument, therefore, in favor of giving up open-air exercise?

Dr. Murray said that one of the most important features of the paper had been the serious yet truthful charge made against the cigarette that it enabled young people to acquire the tobacco habit.

Dr. Mulhall said that he admitted the truth of the observation made by Dr. Langmaid on the local effect of tobacco on the singer's throat. The tenors and sopranos, as compared with other singers, must have very perfect throats and command perfect laryngeal muscular control, and hence not only the local effect but the indirect effect on the nervous system was of importance in such individuals. Ordinarily, smoking produced only a very transient hyperæmia. He had not been so successful as Dr. Langmaid in detecting a smoker by the appearance of the throat. He had never seen pharyngeal mycosis in smokers' throats, and to this extent could confirm the statements generally made on this subject by writers. A medical friend of his, however, had told him that he had a smoker for a patient who was affected with this disease. He could not understand how tobacco smoke could reach sufficiently deep to affect the seat of this affection. He believed he had been the first to call attention to the fact that pharyngeal mycosis was a disease which would sometimes disappear spontaneously and reappear. That tobacco smoking led in a certain degree to the use of stimulants could not be denied, owing to the temporary depression produced by smoking which could be removed by alcohol; but the combined effect of alcohol and tobacco was very bad in the end.

LXII

THE EFFECTS OF TOBACCO UPON THE THROAT

SAMUEL W. LANGMAID, M. D.

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I have been induced to write this short paper because my experience of the evil effects of tobacco on the throat, especially by smoking, has been contrary to what is generally taught in text-books, and because very little has been written on the subject and no record of clinical observations has come under my notice. The subject has generally been dismissed with an opinion for which no good reasons were offered.

For many years I have been compelled to believe that smoking is responsible for certain forms of throat disease, or is an added factor in the injurious effects of climate.

I must acknowledge that my observations have been made in a cold, moist climate, such as exists in winter all along the seashore of the northern United States, and may not hold good in other warmer or warm-moist climates. Indeed, I am inclined to believe that such is the case. But should it be urged that climate alone might be considered responsible for the affections of the throat, I might reply that until tobacco is abandoned there is very little or greatly delayed response to treatment.

The condition of the throat which I have observed is that so exhaustively treated and so truly described by Bosworth in his chapters on acute naso-pharyngitis and naso-pharyngeal catarrh. Bosworth, however, although admitting that tobacco may be an irritant to the pharyngeal mucous membrane, says that he "has always considered the nicotine absorption to be the vicious factor in its use." He admits that the ammoniacal vapor and possibly the small quantity of pyroligenous acid may act as irritants and that it is frequently noticed that a patient suffering from naso-pharyngeal catarrh is greatly inconvenienced and his trouble even aggravated by smoking, and that in such cases it is necessary that the habit should be abandoned. But, he says, "the cases are the exception, rather than the rule." My belief is that in all cases of acute and chronic nasopharyngitis smoking must be abandoned or the cure is delayed. Especially is this the case if cough is a prominent and distressing symptom.

DISEASES OF THE NOSE AND THROAT

Although I believe that much of the hyperemia of the pharyngeal mucous membrane may be due to irritation of the smoke from the burning tobacco, I am forced to believe also that the poisonous effects upon the nervous system may be to a large extent responsible for the vasor-motor disturbances which are plainly visible in the throats of all smokers.

I believe that most of us could hardly make the mistake of not recognizing by the appearance of the throat the non-smoking man, even if he should not apply to us for treatment of a nasopharyngitis. It has been my custom to make such a diagnosis, greatly to the astonishment of the patient. Furthermore, I think the appearance of the throats of most female patients will be noticed to be unlike that of men, even when the pharyngeal mucous membrane is acutely or chronically diseased.

I am inclined to believe that it is largely due to the poisonous action upon the nervous system that tobacco plays such a part, as it seems to me, in producing and perpetuating disease of the throat. The following extracts from recent articles on the action of excessive smoking upon the organs of special sense may seem to you to afford justification for such an assumption.

POSSIBLE ETIOLOGICAL FACTOR IN TOBACCO—ALCOHOL AMBLYOPIA

"G. E. de Schweinitz and Edsall (*Trans. Am. Opth. Soc.*, 1903) attempt to throw some light on what the possible poison may be which produces one or the other of the many changes which have been described by many authors in the optic nerve fibres, or the ganglion cells of the retina, and which manifest themselves by the clinical symptoms."

"Horner, long ago, and de Schweinitz, 1900, suggested that the disease depended on a species of auto-intoxication, and the investigations of Sachs and Casey Wood indicate 'that certain stomach toxins are capable of causing in animals blindness, probably of the type now under consideration.' In seven cases there were evidences of marked disturbance of digestion or metabolism, or of both."

TOBACCO NERVE DEAFNESS

"Wyatt Wingrave (ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY, Sept., 1903) gives the results of his observations of seventeen cases as follows: (1) That they were all well-marked cases

of nerve deafness (unattributable to other causes), occurring in heavy smokers. (2) That the loss of low tones in 50 per cent. suggests an auditory equivalent for a recognizable ocular lesion. (3) That the disease was symmetrical. (4) That there was an impairment of color sense in eight of them, and definite scotoma in four cases. (5) That eighty per cent. showed marked improvement on abstinence from tobacco supplemented by drug treatment; three were cured."

TOBACCO SMOKING

"Beside nicotine, tobacco smoke contains nicotianine, collidine and other pyridine derivatives, acids, resins, carbon dioxide, prussic acid, and ammoniacal salts. Two drops of nicotine placed on a dog's tongue produce in succession efforts to swallow, great weakness, convulsions, and death in less than a minute. Eight drops will kill a horse. Tobacco contains from two to eight per cent. of nicotine, and Le Bon has determined that though most of this is changed in smoking, it appears as other pyridine bodies which are just as poisonous."

"Petit (*Le Progres Medicale*, Nov. 28, 1903) finds that these bodies do not condense much in the warm mouth, so are mostly exhaled. Therefore, the physiological effect of ordinary smoking is not a marked one. Susceptible persons may, however, be much affected by breathing the air of a room in which there is much tobacco smoke."

THE POISONOUS CONSTITUENT OF TOBACCO SMOKE

The gaseous products of the incomplete combustion of tobacco whether it be smoked in the pipe, cigarette, or the cigar, are so complex that the question, To which constituent are the toxic effects of tobacco smoking precisely due? remains unanswered. Of course, it is well known that nicotine is a powerfully poisonous constituent of tobacco leaf, but it is by no means certain that the alkaloid reaches the system by way of the smoke in sufficient quantities to act seriously as a poison. To begin with, the amount of nicotine in tobacco is very small, and there is a reason for believing that the quantity given in previous analyses has been considerably over-presented; moreover, though a volatile poison, nicotine does not occur in the free state in tobacco, but as an organic salt, which is not volatile, and which probably breaks up readily on combustion. It is doubtful whether a seventh part of the total nicotine in the tobacco reaches the mouth of the smoker, and some investigators deny that any nicotine occurs in tobacco smoke at all. But assuming that nicotine is the toxic constituent of smoke, the

quantity must be quite minute, since in most mild tobaccos the proportion is rarely over one per cent. On the other hand, the incomplete combustion of tobacco gives rise to the formation of aromatic compounds, oils, bases, amines, and gases, some of which are undoubtedly poisons, and these are obviously produced in a far larger amount compared with the quantity of nicotine in tobacco.

In this connection too little attention seems to have been paid to the relatively large quantity of the poisonous gas—carbon monoxide—in tobacco smoke. When the insidious nature of this gas is considered, its absorption in the system, which must be very rapid when inhalation is practiced, would sufficiently explain the train of poisonous symptoms which excessive smoking is apt to set up. In some particulars the physiological action of nicotine and carbon monoxide is similar. The dizziness and stupor, the trembling of the limbs and the hands, the disturbance of the nerve centres and of the circulation, palpitation on a slight effort, and the feeble pulse, may be the indications of either carbon monoxide or nicotine poisoning. But since one ounce of tobacco gives no less than one-fifth of a pint of pure carbon monoxide gas when smoked in the form of cigarettes—and probably as much more in the form of cigars or in pipes—it is not improbable that to a very large extent these symptoms are due to the carbon monoxide.

We have recently tried the following instructive experiment, which bears upon this point: Two or three mouthfuls of tobacco smoke from a cigarette were shaken up with a few drops of blood diluted with water in a bottle. Almost immediately the blood assumed the pink color characteristic of blood containing gas, and further observations with the spectroscope confirmed the presence in the blood of carbon monoxide. Similarly a few mouthfuls of smoke from a pipe and a cigar were tried, and the results were even more marked. In this experiment we have some explanation in particular of the evil effects of cigarette smoking, for it is chiefly cigarette smoking that is inhaled—an indulgence by which the poisonous carbon monoxide is introduced directly into the blood. This effect of tobacco smoke upon the blood appears to be of considerable significance.—*Lancet*, Jan. 2, 1904.

The above statements seem to offer sufficient evidence of the poisonous action of excess smoking upon the nervous system. The opthalmic and the aural surgeon have never doubted their effect upon the organs of special sense.

Clinical evidence is, to my mind, sufficient to prove similar action on the throat. The smoker is never quite free from a form of naso-

pharyngitis and sooner or later a mild form of tracheitis appears and becomes chronic. The naso-pharyngitis may reveal itself by the necessity for frequent hemming, or, as frequently occurs, by a morning cough which in some cases is so severe as to cause vomiting, which is frequently ascribed to "catarrh of the stomach."

Not infrequently when the naso-pharyngitis becomes acute, as it frequently does in winter, a most distressing night cough appears, convulsive in its nature and resembling the constantly repeated cough of the child with naso-pharyngeal adenoma. The cause for such a cough is not suspected by physician or patient, and demulcent medicines having been found inefficacious, resort is had to opiates, with the result of destroying the patient's digestion, and the usual systemic disturbances follow.

I have frequently found that the cough would quickly disappear if smoking was discontinued, internal medication being limited to the giving of a placebo, but if the smoking was continued, or not materially lessened, the cough would continue, or, with intermissions, return during a period of months. But I would call attention especially to the effect of tobacco upon the throat and voice of singers.

I have refused for many years to treat the throats of singers and public speakers where smoking was not discontinued, since I believe that treatment which otherwise would be efficacious would be of little avail. The specialist is frequently consulted by a singer or actor for hoarseness which prevents a public appearance. The pharynx and larynx are hyperemic, the secretion of glutinous mucus is excessive, but the real reason for altered quality of voice, or its extinction, is found in the paresis of the intrinsic laryngeal muscles. Either or both vocal bands are relaxed and the upper register of the voice is lost. In such cases a few days or hours of rest of the voice and the treatment which any skilled specialist would apply would be sufficient to restore the voice to a working condition. But the patient must be told that unless he ceases to smoke relief will be delayed.

If it should be said that such a condition may result from over use of the voice or from climate, or both, I shall certainly agree but would yet maintain that smoking not only helps largely to provoke such attacks, but that it retards the restoration of the vocal ability.

I believe then that tobacco smoking is not only harmful to the throat as a direct irritant, but that it produces vaso-motor disturbances of the pharyngeal mucous membrane by its poisonous effects upon the nervous system.

DISCUSSION

Dr. H. L. Swain referred to a rather amusing experience of his some three years ago. At this time a very genteel young lady consulted him for throat trouble, and after carefully examining her throat Dr. Swain informed the patient that if she were one of the students he would certainly say she had been smoking too much. The patient astonished him by replying that it might be due to that very thing, as she was addicted to smoking. She did not return for another visit until about two months ago, when Dr. Swain recognized her, and after again carefully examining her throat gave the same opinion as at first. The patient then informed him that she simply wanted to know how much effect her smoking during the intervening time, three years, had had upon her throat. Dr. Swain acknowledged that he could find no appreciable difference in the condition. The patient complained, however, of having less comfortable nights.

It was Dr. Swain's opinion that there is a certain mark left upon the throat by smoking, which he is often unable to describe clearly enough, for example, to demonstrate to a class of students.

Dr. J. W. Farlow considered it the duty of laryngologists to instruct their patients who are unwilling to abandon smoking entirely as to the best way to smoke with a minimum of damage to the throat. He suggested that one, or even two cigars can, perhaps, be smoked without detriment, if smoked directly after the principal meal and only at that time. At least two hours should elapse between the last smoke and bedtime. The mouth should be thoroughly rinsed with cold water after smoking.

Dr. Langmaid, closing the discussion upon this subject, stated that one could be materially aided by stopping smoking for a time. He found this method of treatment to be productive of good results in many cases.

With regard to the effect of tobacco upon singers' voices, he had known several singers who have tried to smoke when the throat was affected, but who were obliged to give it up. He was willing to admit, however, that deep voices, such as baritone, bass or contralto, are not so easily affected by tobacco smoke as were the higher voices, viz., the tenor and soprano, since the beauty of tone in the lower-pitched voices does not depend, for reasons foreign to the scope of this paper, upon the absolute integrity of the vocal bands.

Dr. Langmaid stated that there were more female smokers than one would believe, and said that it is hardest for a woman to give up the habit when once acquired.

(When this was read Dr. Mulhall had been dead five years and could not defend his position.—Ed.)

Society Proceedings

JOINT MEETING

CHICAGO OPHTHALMOLOGICAL SOCIETY
CHICAGO LARYNGOLOGICAL & OTOLOGICAL SOCIETY

Meeting of Monday, February 8, 1943

DRS. LOUIS G. HOFFMAN AND G. HENRY MUNDT, PRESIDING

Symposium On Head and Face Pains

(Abstract of Proceedings)

Internal Medicine

G. W. SCUPHAM, M. D.

The lay public has been so well educated to the fact that eye strain and eye diseases are frequent causes of headache that they go to the ophthalmologist, and the otologist has his turn because of the belief that sinus headaches are common. It is a difficult problem because of the multiplicity of illnesses of which headache is the outstanding symptom. From the standpoint of the internist, not only is the diagnosis difficult, but the therapeutic problem is often more so. If we limit ourselves to any one of the fields of medicine in which headache is important, we are likely to fail to arrive at a conclusion in any particular case.

A number of mechanisms may result in various types of headache, but so far as head and face pains are concerned, these are not so important. Pain may be the result of local diseases or local reflex phenomena. Some blood vessel disorders are characterized by pain. Arthritis of the temporal vessels does result in a throbbing, burning type of pain localized in the region of these vessels, often associated with evidence of an inflammatory process. Herpes zoster is a fairly common cause of head pain. Tumors of the scalp and skull, multiple myeloma and osteitis of the skull might also be mentioned.

Headaches are more important to the internist than head and face pains. The character of the pain seems to be different: headache arises within the head, whereas head and face pains are more or

less superficial. Headache is extremely variable in different individuals. It is uncommon in children, and it is less common in aged individuals than in middle adult life.

The majority of headaches are merely part of the general symptomatology of the disease picture. In almost all acute infections headache is an important symptom. Typhoid fever is often characterized by long continued headache; influenza and acute respiratory infections, by headache at the onset. An example of toxic headache is that resulting from sulfathiazole; alcohol is also a cause of this type; carbon monoxide poisoning is also toxic, but often results in structural changes. In acute nephritis headache is an important symptom of the onset of the disease, associated with nausea. It is in part toxic but there may be a rise in intracranial tension; in the uremic phase of chronic nephritis the headache is probably toxic. Headache is a common and extremely important symptom in chronic malaria, is persistent and severe, and disappears with control of the disease.

Hypertension is the major vascular disease in which headache is important. The inhalation of amyl nitrite results in headache and fall of blood pressure. This is an interesting contrast in the mechanism of headache: in persons having hypertension a fall in blood pressure often overcomes the headache. Many with severe hypertension never have headache, and many moderate hypertension complain of severe throbbing headache often continuing for days without marked exacerbation of the blood pressure. In general, patients whose hypertension is in the malignant stage are subject to severe headache, probably because there is marked vasoconstriction of the arterioles of the central nervous system.

The headache which resembles the type caused by injection of histamine may be confused with migraine because it is often unilateral. There is no history of familial headache. The headache often begins at night. There is often flushing of the head and face on that side, tenderness of the temple and over the carotid artery. Pressure on the carotid may result in relief. A small amount of histamine injected subcutaneously can initiate an attack. The recognition of this type is important because relief may be obtained by the therapeutic administration of histamine.

There are a great variety of rheumatic headaches, from that of acute rheumatic fever which may be mistaken for brain tumor, to a mild occipital headache of chronic nature. Perhaps the common type is associated with fibrositis and myositis as well as with cervical osteo-arthritis. Such headaches occur with increased tension of the muscles of the spine and neck.

Reflex headache is more difficult to differentiate. It is often associated with disease of the pelvic structures. Constipation is said to cause headache reflexly and evacuation of the lower bowel brings relief.

The typical features of migraine headache are well known. The family history is so common that if we do not find it we doubt the diagnosis. There is a slow development of headache with nausea and vomiting, relief and sleep, often preceded by aura. It is extremely variable in some individuals, and it sometimes disappears at or near the menopause. Another striking feature is the association with the menstrual cycle. Migraine may be precipitated by a wide variety of factors; food allergy, emotional states, certain endocrine abnormalities, particularly the gonadotropic factor, fatigue, infection and many others. It is commonly thought to be incurable, but much can be done if the problem is studied. Treatment should be directed toward elimination of the exciting factors when possible.

Neurology

LEWIS J. POLLOCK, M. D.

When a stimulus is applied to the skin or the mucous membrane on the exterior of the body, sensation is transmitted by the sensory fibers of the craniospinal nerves and reaches consciousness directly through the appropriate sensory tracts. Thus, inflammatory and other pathologic processes of the skin and the mucous membrane produce stimuli carried by ordinary sensory cutaneous nerves and are localized by one to the area stimulated.

When the subcutaneous areas are stimulated, sensation is transmitted in two ways: first, by the ordinary sensory components of the craniospinal nerves carrying deep sensibility, in the case of the head and face, by way of the sensory components of the third, fourth, fifth, sixth, seventh, ninth, tenth, eleventh and twelfth cranial nerves; second, by a more complicated mechanism producing referred pain, for example, the shoulder tip pain occurring when the central portion of the diaphragm is stimulated by diaphragmatic pleurisy. The impulse travels by way of the phrenic nerve through the posterior roots of the fourth and fifth cervical nerves to the spinal cord, there making a synapse with the descending short fiber tracts to the points of origin of the cervical sympathetic nerves, then through the preganglionic and postganglionic fibers to the skin where a chemical change is produced stimulating the sensory end-organs, and sensation is then

carried by the sensory spinal nerves into the spinal cord and by its appropriate sensory tract into consciousness. The location of pain is then referred to the skin over the shoulder tip.

The same mechanism applies to the head and face. In the case of vascular headaches and perhaps migraine, stimuli occur as the result of dilatation of the blood vessels; impulses travel by way of the nervi vasorum originating in the cranial nerves, perhaps also the upper cervical nerves and find their way into the brain stem and medulla. There a synapse with the short descending pathway of the cervical sympathetics occurs; impulses are sent over the postganglionic fibers to the skin where again chemical changes produce a stimulus in that area, and impulses carried by the particular sensory nerve involved, chiefly the fifth but also others, enter the brain stem. This holds true also of distension of other subcutaneous tissue as well as traction on the meninges and the dural sinuses. This can be proved by experiments in which the pain ensuing from faradic stimulation of the superior cervical ganglion can be stopped by sectioning the sensory root of the fifth nerve. The pain cannot be stopped by severing the preganglionic fibers when the appropriate anterior roots are severed or by cutting the cervical sympathetic chain below the superior cervical ganglion.

Usually head pain does not occur as the principal symptom of intracranial disease. Although headache may be the presenting symptom, it is not the sole symptom in intracranial tumors. Diplopia, hemiparesis, facial paresis, ataxia, loss of visual acuity, vomiting and mental disturbances are always at times associated with the headache. Headache, when present, is associated with vomiting which may be projectile in character and usually does not lead to alleviation of the pain. Here the headache is sharp and severe and continuous; it may be a throbbing, stabbing, boring pain. It is often brought on by sudden change of posture and may disappear by changing the position of the head; in intraventricular and infratentorial tumors, the patient may hold his head in a position which tends to lessen the possibility of the occurrence of pain. It may be associated with suboccipital tenderness and rigidity of the neck. It is increased on jolting and straining and, with sudden exacerbation of pain, vomiting may occur.

The location of pain is not characteristic, nor is it an index of localization of the tumor, The character of the tumor may influence the type of headache and its severity. Rapidly growing tumors are associated with more headaches; hard tumors cause more pain; circumscribed tumors produce pain of greater intensity than do infiltrating tumors. Tenderness to percussion of the skull at times serves to

bring out an area of circumscribed tenderness which may indicate intracranial disease.

Associated signs and symptoms lead to the diagnosis. Hemiplegia of sudden onset points to hemorrhage, thrombus and embolism; the sudden onset of excruciating suboccipital pain with loss of consciousness, rarely hemiplegia, and rigidity of the neck, characterize subarachnoid hemorrhage, usually due to a ruptured cerebral aneurysm. Inflammation of the leptomeninges, alone or with encephalitis, is associated with rigidity of the neck, Kernig's sign, Brudzinski's sign, and evidence of inflammatory disease is found on examination of the cerebrospinal fluid. Serous meningitis with paroxysmal hydrocephalus is characterized by the occurrence of definite attacks of headache, vomiting, sometimes choked disks, and signs of interference with cerebral function. Such attacks, after a relatively short course, may disappear and a considerable time elapse before another occurs. In such cases one may often obtain a history of another phenomenon of anaphylaxis, as angioneurotic edema of Ménière's syndrome.

Most cerebral diseases produce interference with function of motion, sensation, tone, synergy, speech, reflexes and cranial nerves. No more than a consistent difference in the activity of deep reflexes upon the two sides may be noted, but when this is combined with diminished superficial reflexes on the same side, it is a strong indication of organic disease. Changes in the visual field may be found long before change in the optic nerve, especially in temporal lobe lesions, where a quadrantic anopsia and a headache may be the sole symptoms of tumor. Whether encephalitis uncomplicated by meningitis can produce headache cannot be stated. Many of the encephalitides are associated with meningitis, and in lead encephalopathy a marked change in renal function may be present, which in itself may produce marked headache.

In a very large number of patients suffering from headache careful search reveals no organic disease. Such headaches may be termed "psychogenic," or perhaps better, headaches associated with neurosis. Usually the patient does not mean that he has pain in the head when he complains of headache. It is a feeling sometimes describable, at times not; always it is "intense," "terrible," "horrible," "splitting," "unbearable." It is the hyperbole and exaggeration which point to the condition. The sensations complained of are also myriad. The so-called pain may involve any part of the head, and shifts from day to day or from hour to hour. It is continuous, is usually unaffected by weather or by ordinary changes in position. It is not accompanied

by nausea or vomiting. It is always increased by making decisions and always by work. It is relieved by reassurance, whether by a physician's statement or by favorable observations by the patient. If the patient becomes interested in any pursuit, so long as the interest lasts the headache will abate; it is abated by any new treatment or doctrine. It is worse in crowds, and is increased by excitement, disputes, quarrels, and domestic, social and business conflicts.

As is the case with sensations relative to phobias relating to the heart or the stomach, so with this headache. A real pain or discomfort of organic origin may often have preceded it; it may follow a migraine, an indurative, ocular or sinus headache, or may co-exist with them. Prominent among the symptoms are depression, abulia, inattention, difficulty in concentrating, forgetfulness, introspection, anxiety, fears, indecision, fatigue and insomnia. It is important not only to distinguish these headaches from organic headaches, but it must be remembered that they may be the beginning of a more serious condition, a beginning melancholia, dementia precox, or dementia paralytica.

Often pain in the head or certain types of headache are classified as neuralgia, namely, auriculotemporal or occipital neuralgia. This I believe is a mistake. If we accept trifacial neuralgia as characteristic of the neuralgias, then sudden paroxysms of severe pain in the distribution of the sensory supply of the nerve, lasting only a fraction of a second, and brought about by touching a trigger or algogenetic zone, are seen only in relation to the trigeminal or the glossopharyngeal nerve.

The characteristic neuralgia affecting the trigeminal nerve is observed usually when no underlying pathology can be demonstrated even when the gasserian ganglion is inspected. At times it occurs in relation to tumor of the gasserian ganglion, to angle tumors rarely, and to multiple sclerosis. It is not related to any other extraneural disease, as disease of the sinuses, the teeth or other structures of the head and face. The characteristics of the pain are unique. The pains are always referred to the same zone, supraorbital, infraorbital or mental, or two or all of the branches. They may occur seemingly spontaneously but can always be brought on by touching the area which is the trigger zone, or by movements stimulating such a zone—talking, chewing, swallowing. The area stimulated is not always the area in which pain ensues. The pains are very severe, sharp, shooting, electric-like, last but a few seconds or may consist of a succession of shorter ones. There is no relief other than interruption of the sensory fibers of the fifth nerve.

Allergy

SAMUEL M. FEINBERT, M. D.

From an allergic standpoint there are two main types of headaches; the classical migraine and the simple but frequently recurring headaches. We believe there is no real etiologic distinction between the types; the migrainous are merely a more severe form. We have observed many patients whose ordinary recurrent headaches go on into migraine, and other patients whose headaches vary from the simple to the typical migraine at different times.

What is the mechanism of migraine? It has been demonstrated that angioneurotic edema produces cerebral symptoms and that cerebral vessels have a vasomotor control. Several years ago a young woman who had violent migrainous symptoms was finally operated on for suspected brain tumor. Marked edema of the brain was noted but no tumor was found. Following the operation she had a defect in the skull. It was not observed that the onset of a migrainous attack was initiated by a preliminary pallor of the face and depression of the skull area. As the attack progressed there developed definite bulging of the decompressed area. Allergic studies showed definite clinical sensitivity to specific foods and the latter precipitated the headaches and the bulging of the defect. It would appear, therefore, that the mechanism of migraine is probably a cerebral angiospasm followed by vasodilation and increased intracranial pressure.

What evidence have we for the allergic basis for headaches? Dr. Scupham has already mentioned the great tendency to inheritance in migraine. The majority of patients give a family history of migraine, but a large percentage also give a history of other allergy in the family. It is generally overlooked that in allergy not only is there a general tendency to the inheritance of allergy but a special tendency to have certain allergic manifestations predominating in the family. Antecedents with urticaria are more apt to have offspring with urticaria than with other forms of allergic reaction; antecedents with migraine are more likely to have offspring with that disease than any other allergic manifestations. The fact that migrainous attacks are frequently precipitated by nonallergic factors such as fatigue, constipation, excitement, weather changes and endocrine cyclic phenomena does not detract from the allergic concept of the disease. We know that such precipitating causes can be instrumental in being the "trigger" to other allergic phenomena such as asthma, rhinitis and urticaria. It is true that only a small portion, perhaps a fourth, re-

spond to skin tests. And yet we find that in some of the other allergic manifestations, such as urticaria and gastro-intestinal allergy, the incidence of skin reactions is also small. By clinical means and observation we can assure ourselves that many patients have their headaches from foods in spite of negative skin reactions.

By the use of skin tests, simple observation, diary records and restricted diets we can usually make a diagnosis. We may say conservatively that half of these cases can be shown to be allergic; about the others we believe no satisfactory explanation exists at present. The majority of the allergic patients are sensitive to foods, the most common of which are wheat, milk, cocoa, peas and beans, potatos, pork, eggs and onions. It should not be forgotten that inhalant allergens may also cause migraine.

Endocrinology

HUGO R. RONY, M. D.

It may be expected that endocrine glands play some role in the etiology of headache for three reasons: (1) Two glands, the hypophysis and the pineal gland, are located in the intracranial cavity; (2) hormones are known to affect secretion of the cerebrospinal fluid as well as retention of water in various tissues, including possibly the meninges and the brain; (3) glands participate in a number of factors known to be concerned in the production of headache—blood pressure, certain metabolic processes, the autonomic nervous system, the level of sugar, calcium, and sodium in the blood.

It is difficult to obtain reliable statistical data in regard to the frequency of endocrine headache inasmuch as the diagnosis of endocrine disturbance is sometimes a matter of opinion. Further, even in the presence of definite endocrine disturbance, its role in the production of the headache in a given case may be open to question. It is probably safe to say, however, that the number of cephalalgias where glandular disturbance is a contributory factor is quite frequent, while true or primary endocrine headache is relatively rare.

In tumors and hyperplasias of the hypophysis, headache is a prominent symptom; it is more or less constant, bitemporal or occipital. It is believed to be due to distension of, or pressure upon, the capsule of the gland or the dural diaphragm above the gland. Eosinophilic, basophilic or chromophobe tumors may produce this headache regardless of the functional state—deficiency or hyperactivity—of

the gland. Removal of the tumor or deep x-ray therapy may completely relieve the headache. There is some evidence that the headaches of pregnancy, artificial or natural menopause, and so-called premenstrual headaches may be of pituitary origin, probably due to mechanical effects of the hyperplasia of the gland known to occur in these conditions. Such headaches may be successfully treated by large doses of estrogenic hormone preparations which are known to exert an inhibitory effect on pituitary hyperplasia.

Tumors of the pineal gland may produce severe headache of the type seen in brain tumors, especially if they lead to compression of the sylvian duct and cause internal hydrocephalus with conservative increase of intracranial pressure.

Headache is not infrequent in disturbances of the thyroid gland, either hyper- or hypothyroidism. Such headaches are usually mild with no characteristic localization. That they are related to the thyroid disturbance is shown by the fact that they are relieved by specific therapy, administration of thyroid substance in hypothyroidism, or thyroidectomy in hyperthyroidism.

Headache is a prominent symptom of Addison's disease or other forms of adrenal insufficiency, and may be relieved by the administration of adrenal cortex extract. In hyperinsulinism, headache may be an element of the hypoglycemic syndrome. Characteristic of this headache is its onset when the stomach is empty, with prompt relief after food intake. Hyperglycemia, on the other hand, does not in itself produce headache; however, headache frequently accompanies diabetic acidosis, and severe headache in the uncontrolled diabetic may be a danger signal of impending coma.

Headache in various conditions of doubtful glandular etiology may present a considerable diagnostic and therapeutic problem. Thus it may be difficult to decide whether headache in patients with a hypotension-fatigue syndrome, certain ovarian disturbances, or male climacterium is of glandular or psychogenic origin. Even therapeutic success with specific glandular preparations may not answer the question of the nature of the headache in view of the possible suggestive effect of treatment. In certain forms of obesity, especially when accompanied by hyperostosis frontalis interna (Morel's syndrome) or by painful lipomatosis (Dercum's disease) headache may be a prominent complaint. Reduction of weight in such cases is usually followed by more or less complete relief of the headache, probably because of the lowering of blood pressure and the lessening of water retention as a result of weight loss.

Ophthalmology

BEULAH CUSHMAN, M. D.

Patients with headache come to the ophthalmologist sooner or later, as it has become almost a maxim that errors of refraction and muscle balance cause headache and asthenopia, and this belief is fostered by advertisements. The eye is particularly sensitive to neurosis since it is a highly specialized organ.

Of the twelve cranial nerves, four go directly to the eye and three have distributions to the eye. The extensive distribution of the fifth nerve from the midbrain down to the second cervical level and the numerous inter-relationships which it forms with the nuclei of origin of all the other cranial nerves constitute one reason why headaches so frequently result from many different causes and are so vague in distribution. The association of the trigeminus with the vagus accounts for the vomiting which accompanies acute glaucoma. This also explains the relief of dyspepsia obtained by the proper correction of errors of refraction and muscle balance.

Ocular headaches have been divided into three groups: those due to retinal irritation, those due to organic disease, and those due to eyestrain.

Retinal irritation may follow glare from any sudden change of environment from a dull to a bright light, or from the use of a torch in industry. The range of sensitivity varies with the individual, partly according to the amount of pigment in the retinal pigment layer and the choroid. Ophthalmic migraine, a rare condition, may be precipitated by glare and is the type of headache which has been described as associated with palsy of an ocular nerve, generally the oculomotor. At first the palsy is temporary, later becoming permanent. The pain is diffuse, beginning in the temporal region and spreading to the occiput. Pain and nausea always precede the paralysis. The pain in ophthalmic migraine is usually on the same side as the hemianopsia, whereas in typical migraine the pain is on the opposite side. The paralysis, which may involve the iris and the muscle of accommodation, usually passes off in the first attack. The attacks occur only a few times during the patient's life, but each attack may continue for days, weeks or months. The involvement of the oculomotor nerve has been constant in all published cases, but the pathologic pictures show no uniformity.

Organic diseases produce ocular pain according to the degree of abnormality of the ocular nerves and muscles. Foreign body sensa-

tion and discharge are present with inflammation of the conjunctiva, cornea and sclera.

Ciliary neuralgia is the type of pain present with iritis and cyclitis, is usually worse at night, and varies in intensity. Neuralgia of the eye has also been described as pain on movement of the eye and tenderness of the ocular muscles after exposure to cold air. Closely allied to this condition is neuralgia of the forehead. The symptoms may be associated with transient paresis, which responds to heat and salicylates.

The pain in acute glaucoma extends along the distribution of the trigeminus nerve. Chronic glaucoma and secondary glaucoma have a neuralgic type of pain referred to the face, cheek and temporal areas, often mistaken for sinus infection until the vision becomes affected.

Retrobulbar neuritis produces a pain deep in the orbit, increased upon rotation of the eye; this pain may be present several days before blurred vision develops.

Pain in proptosis, as found in thyrotoxicosis, orbital tumor and cellulitis, varies according to the degree of distortion of the ocular muscles and nerves and exposure of the cornea.

A refractive defect present for many years is unlikely suddenly to exert a malign influence according to Butler, unless some other factor is added—overstudy, work under unfavorable conditions, debilitating illness and psychic disturbances. Headaches of recent origin should be due to a recent cause.

Ophthalmic headaches are presumed to be due to overwork of the muscles of accommodation and fixation; the height of the pain is reached late in the day and disappears after rest. The infrequency of headaches in persons with monocular vision is said to be due to absence of effort made for fusion through complex actions. Overaction of the ciliary muscles controlling accommodation producing fatigue and spasm may be followed by headache. Refractive errors predispose to headache, as does muscle imbalance. The insertion of the frontalis muscle into the upper lid of each eye participates in the contraction of the orbicularis palpebralum; the frontalis on contraction pulls on the epicranial fascia, and this in turn pulls on the occipital muscles causing fatigue and spasm.

Headaches of ocular origin are probably most often found in the presbyope with the receding near point. Many persons complain of ocular discomfort who have high degrees of hypermetropia and

astigmatism or heterophoria, which had caused no previous handicap. Aniseikonia is a cause of discomfort in patients with unrelieved symptoms of asthenopia or photophobia. This may be suspected in anisometropia, in unequal accommodation with lenses of unequal curve or thickness, space perception anomalies, and in the patient with good vision in each eye who prefers to use one eye only and occasionally in a patient with reading disabilities or migraine.

Otolaryngology

ARTHUR W. PROETZ, M. D.

ST. LOUIS, MO.

Reliable statistics indicate that probably less than five per cent of headaches are due to sinus trouble. Undue emphasis has been given to sinus headache by the public, which has been recently plied with semitechnical literature on sinusitis while being kept in ignorance of the other thirty causes of headache. The physician must guard against accepting the patient's diagnosis merely because some sinus infection is present. Many people have headache; many people have sinus infection; the two are often not related.

While the mechanism of headache is not known, much light has been thrown upon it in recent years. It is usually associated with stretching or distortion of certain definite portions of the meninges or with the dilatation of certain arteries, notably the middle meningeal. The sinuses are closely related to these structures. Congestion and inflammation in the sinuses may produce typical headache.

However, these disturbances may not be peculiar to the sinuses themselves but may be of a vascular nature and result from conditions elsewhere in the body. It is my impression that there are people who are headache subjects; that is, that many stimuli of various types produce vasomotor disturbances which set up the headache mechanism and produce the symptom typical of the individual.

Mere stretching of the nasal mucosa does not produce pain. A number of cases have now been observed of sudden edema stretching the sinus lining to ten times its normal thickness without any subjective symptoms. It does not follow that stretching of the periosteum would be painless. This may be analogous to a diffuse otitis externa, which is exceedingly painful.

The existence of a "vacuum" pain of any duration is open to doubt. I can find no evidence in the literature of any experimental proof that it exists. No physiologist whom I have consulted is willing to say that the sinus mucosa absorbs oxygen. It is pointed out that a system of tissues may react specifically in absorption or secretion of a gas. If no selective action exists and only the usual exchange of gases occurs in a sinus, then as much carbon dioxide must be given off by the membrane as the oxygen which it absorbs, and since carbon dioxide has a slightly greater volume than oxygen, a *positive* pressure must result if the ostium is closed.

Another mechanism may be at work which I have not seen described: sudden engorgement or sudden collapse of a sinus membrane in the presence of a closed ostium may conceivably produce positive or negative pressures. Whether these produce headache I do not know. In certain individuals slight exhaustion of air from the nasal fossae does produce headache.

Observation of pain in cases of known acute sinus activity, namely, acute empyema of the frontal and maxillary sinuses, leads to the conclusion that pressure on an acutely inflamed area causes severe pain. When the pressure is relieved the character of the pain changes. Although the mucosa is still acutely sore, the pain in no way resembles a so-called sinus headache as we understand it. It is not gone in half an hour. We are led to the conclusion that sinus headaches which come and go are the result of vascular disturbances (in or out of the sinus) and not of a fixed pathologic change.

Some nasal headaches can be demonstrated to result from the impaction of jets of air during inspiration against the nasal ganglion or its tributaries. These jets are the result of constricted airways. The direction is determined by the topography of the nose and its irregularities.

It is difficult to obtain a balanced viewpoint from the literature on headache. Many authors are themselves victims of the malady and their accounts and interpretations are often highly tinged with their own experiences. This is entirely understandable, since a symptom so completely subjective can in any case be best studied by its victims.

There remains the problem of practical approach. Anyone seeing many headache patients (and who does not) must be struck by the fact that these people are prone to make their own diagnoses, which lead them to the rhinologist or the ophthalmologist or the dentist or the allergist or, what is more likely, to all of them in succession. They are commonly told, "It isn't your eyes, it must be your sinuses,"

or "It isn't your sinuses, it must be your teeth." They are seldom told, "Your headache is due to one or two or more of some thirty possible causes and we will try to find out which one it is."

In my own hands, the most direct method of arriving at some indication of the nature of a headache is a complete history both of the headache from the standpoint of the attack and of the background, and of the patient in general. A complete printed questionnaire helps greatly to visualize the case as a whole and to evaluate it. Important also is a complete daily record of the patient's contacts, diet and activities. Again, a prepared chart with which I am thoroughly familiar has many advantages over a haphazard diary or even a carefully recorded diary according to some system devised by the patient. Since the important points in such a diary are often the minute details, standardized records are of great help.

In the treatment of vascular headache and, in fact, of some others, to afford relief while investigation is going on, I find ephedrine with one of the barbiturates by mouth very useful.

I may also add that many headaches having the characteristics of sinus pains disappear on the administration of thyroid extract. A low basal metabolic rate is not always typical in these patients. I have commonly noted improvement on giving thyroid even when the rate was +5 or more.

DISCUSSION

DR. PETER BASSOE: It might have been well if someone had discussed recent research on the mechanism of headache. At the last meeting of the Chicago Neurological Society, Dr. Harold Wolff reported on the work by his group in New York. They have made innumerable experiments on people whose heads had been opened and determined that the most sensitive areas are near blood vessels, which is analogous to what is seen in the peripheral nerves. The median and sciatic nerves with their arteries surrounded by nerve fibers are the areas most frequently affected by causalgia.

One speaker is missing on this program; no one discussed teeth. Even in this enlightened age a great many people have been deprived of teeth without good reason. One striking example was a woman with beautiful teeth, who had pain which she localized in a couple of teeth. These were found to be normal upon removal, but then the pain shifted to other teeth, which were also removed, until she had lost many teeth at the time she came under observation. On questioning it was found that she was in a disagreeable situation from

which she could see no escape. It was possible to point out to her how this could be straightened out and the pain disappeared and the rest of her teeth remained.

Dr. Feinberg's remarks about edema and allergic conditions causing pain are interesting. One patient developed a syndrome of brain tumor, chocked disk, vomiting, severe headache, but no localized signs. A decompression was made and he was well and had no further symptoms. No tumor was found. He moved to another part of the country and then developed typical angioneurotic edema. Undoubtedly his symptoms of brain tumor were due to edema of the brain.

Another patient, a woman, had sudden severe brain headache, aphasia and hemiplegia. She had been taking care of a child with scarlet fever, and brain abscess was suspected. She went into coma. The brain was explored and nothing but edema was found. She recovered, but temporary aphasia recurred at each menstrual period, so this was nothing but a severe menstrual edema.

DR. G. W. SCUPHAM: Dr. Feinberg's conception of migraine as being essentially an allergic phenomenon is generally accepted. It is analogous to asthma in many respects. Although it is not always an allergic factor that precipitates the episode, that does not alter the pattern. Just as asthma may be precipitated by many exciting factors, entirely foreign to allergic influence, so may migraine. The endocrine aspect deserves more consideration. Just what part the endocrines play in the mechanism of headache it is difficult to say.

Dr. Proetz's scheme for study of the subject is splendid. When a patient has sinus infection it does not mean that it is the cause of his headache. The same is true of hypertension.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Meeting of Monday, March 1, 1943

THE PRESIDENT, DR. G. HENRY MUNDT, IN THE CHAIR

Congenital Familial Deaf Mutism in Six Children

CARL H. CHRISTOPH, M. D.

(This paper appeared in full in the June issue)

DISCUSSION

DR. WALTER THEOBALD: This presentation is a striking example of a type of deafness for which there seems to be no explanation, inasmuch as there is no history of hereditary deafness. Since he has made such an exhaustive study of the family tree, I wonder whether he has any theory as to the cause. Further, is it nerve deafness or middle ear deafness?

DR. E. W. HAGENS: Dr. Christoph's study of this family brings to mind our examinations of a number of children in the schools for the deaf a few years ago; more than 5,000 were examined in various parts of the country. In classifying these cases into what we considered congenital or acquired deafness, there were about 3,500 classified as congenital; of that group 1,374 gave a history of either consanguinity or heredity. We found 6 instances where 6 children in a given family were apparently born deaf. In regard to the parents, 4 per cent of the 3,000, or 10 per cent of the group showing heredity and consanguinity, had parents who were deaf. In many instances the children were apparently the ones born deaf in the family, so far as the history showed.

The reason for such hereditary deafness we never learned and, so far as I know, no one has ever worked that out. Some possible causes have been advanced by Taylor, such as the use of quinine for the mother during delivery. The pathology is difficult to ascertain. Some cases show one thing, some another. Certainly it is difficult to say whether it is inner ear or nerve deafness, or both. In our study

the outer ear canal was normal in most cases. Four-fifths of the children had some sort of vestibular response. We used the turning test on all, the caloric test on a certain number. It is difficult to know how extensive the malformation is. The cochlea may be present without nerve connection; the nerve may have disappeared. The presence of the cochlea does not indicate that it is functioning. The middle ear may be malformed as well as the inner ear. I have never been able to find a rule that fitted all cases. The cochlea was originally connected to the brain by the auditory nerve, as otherwise it would not have developed. Then, at some time during fetal life the nerve was destroyed so that at birth there was a cochlea, but it had no connection to the brain.

DR. HANS BRUNNER: I would like to ask whether the boy with supposedly normal hearing has normal speech. Further, I would like to emphasize that all the deaf children had measles in early childhood. It is therefore possible that this deafness is not entirely congenital.

I do not believe the function of the labyrinth has any influence upon the development of language, although the labyrinth does act upon the tonus of the vocal cords. Nevertheless, I agree that deaf children without functioning labyrinths have, as a rule, poorer speech than those with functioning labyrinths. The reason is not that in congenital deafness the function of the labyrinth is saved, whereas in acquired deafness it is lost; it is that in congenital deafness the deafness is frequently not complete, as it is in acquired deafness.

The etiology of congenital deafness is not clear. For many years it was held that incomplete development of the cochlea produces deafness and deaf-mutism. Several years ago I examined the temporal bones of a woman about 60 years of age, who had died from severe erysipelas. She had had entirely normal speech and fairly good hearing, as proved by repeated examinations. To my great surprise, the cochlea of that woman presented exactly the same type of malformation as had been considered characteristic for deaf-mutism.

So far as consanguinity of the parents is concerned, that cannot be considered an absolute cause of deafness in the children. In the old legends the great heroes frequently came from consanguine parents. Although we do not live in a world of legends, the motif of these legends is never in definite contradistinction to the observations in actual life. As a matter of fact, statistics have proved that the children of consanguine parents are not always deaf if the parents are entirely normal and healthy individuals.

DR. CARL H. CHRISTOPH (closing): This family does not follow the Mendelian law, but there must have been a dominant ancestor that handed down this deafness, probably on the male side; this in spite of the fact that there is absolutely no history of deafness in the family. So far as the location of the pathology is concerned I do not know how this can be proved, as both high and low tones are absent. It may be in the stria vascularis, the nerve, or in the pathway to the brain.

Hughson and his co-workers, in a report on the children in the Pennsylvania School for the Deaf, divides the deafness of these children into embryonic and nonembryonic. He classes as embryonic those who have not had intra-uterine injury or injury at birth. If the child appears to be deaf and has made no attempt to talk in the first few years, that is considered embryonic deafness even though the child has had measles or some other disease in early childhood. In Hughson's report 38 per cent of the children had deafness of the embryonic type. I think this is a better classification than congenital or acquired deafness.

Orbital Cellulitis Complicating a Maxillary Sinusitis

EDWIN J. BLONDER, M. D.

(This paper appeared in full in the June issue)

DISCUSSION

DR. GEORGE WOODRUFF: I did not hear Dr. Blonder say whether or not an incision was made into the orbit, or whether the antrum operation alone sufficed. Was there any evidence to show where or how the maxillary sinusitis produced the orbital cellulitis?

DR. HOWARD C. BALLENGER: Was there any evidence of an osteomyelitic process of the maxilla? I do not recall a definite case of orbital cellulitis secondary to a maxillary sinusitis. However, the late William Mullin was of the opinion that the maxillary sinus was a frequent cause of orbital cellulitis. I have never been able to follow him in this belief.

The only case I recall that might have been due to a maxillary sinusitis was in an infant with osteomyelitis of the maxilla and maxillary sinusitis, with later orbital cellulitis and abscess and final exten-

sion to the cavernous sinus. Autopsy did not determine the exact sequence of events by which the orbital cavity became involved.

DR. M. A. GLATT: In examination of dry specimens of the skull, one notes that the infraorbital nerve traverses a canal at the roof of the maxillary sinus where the bone is as thin as, or thinner than the lamina papyracea. In the orbital cavity the canal is incomplete. Thus infection of the mucosa can easily penetrate the globe. I have had this experience with an infant in whom both eyes became involved. The question there was also whether it was a case of thrombosis of the cavernous sinus. There were no signs of the typical bluish discoloration of the bulbar conjunctiva as seen in cavernous sinus involvement. The incision had to be made through the lower lids because in infants the antrum is not well developed. The child recovered rather rapidly after the incisions were made, which proved that these are not all cases of osteomyelitis. In Dr. Blonder's case I am sure there was no contraindication to incision of the lid prior to, or at the time of, exposure of the antrum.

DR. E. J. BLONDER (closing): In reply to Dr. Woodruff, my diagnosis was cellulitis of the orbit. I was unable to demonstrate pus in the orbital wall although some may have been present, because I did not open the orbit externally, through the antrum, or through the ethmoid. When I operated I felt I might have to do some later surgery, but I made an effort to eliminate the infection as much as possible and felt that the Caldwell-Luc operation and the transantral ethmoidectomy were sufficient. The patient recovered without further surgery and I do not know whether or not a small amount of pus was present in the orbit. I felt that extension of the infection occurred through the orbital wall of the antrum because of the marked reaction of that area seen at operation. A fine flexible probe passed in the area of the granulations did not go through the orbital wall. If the orbital cellulitis had not receded, I probably would have perforated this area in the search for pus at a subsequent operation.

In reply to Dr. Ballenger, I found no osteomyelitis at the time of operation. The bone of the antrum in a child of 14 is rather soft. The laboratory report was unsatisfactory. One of the patients reported on by Dr. Ballenger in his series from Children's Memorial Hospital had an antrum window made and osteomyelitis developed in the roof of the mouth. The description of that case somewhat resembles that of my patient.

The limitation of motion of the eyeball upward was a very interesting phenomenon. I was not sure at first whether or not a cavernous sinus thrombosis was complicating the picture. However,

I feel now that this limitation was due to inflammation of the inferior oblique muscle in the region of the lower lid, which interfered with its synergistic action with the superior rectus muscle in rotating the eyeball upward.

Dr. Glass asked why the lid was not incised. With the great amount of infection present in the antrum and associated ethmoid I did not feel that this procedure would clear the peri-orbital cellulitis or the sinus infection. Had it been necessary to incise the lid during operation I would not have hesitated to do so.

Malignancy Mistaken for Nasal Polyp

ALFRED LEWY, M. D.

This patient was a man of middle age who presented himself for relief of nasal obstruction. I saw what appeared to be an ordinary solitary nasal polyp, which was freely movable. At operation it was removed without any difficulty or excessive bleeding. When the laboratory report of villous carcinoma was received he was referred to the Tumor Clinic for treatment. Two or three weeks later he entered County Hospital, where he died of an intracranial complication, presumably extension of the tumor to the brain. No autopsy was obtained.

Our x-ray findings were those of ordinary ethmoiditis, and we felt the polyp should be removed before treatment of the ethmoiditis was instituted. There was nothing about the polyp to attract attention clinically. It apparently came from some place in the roof of the nose; the exact attachment I could not determine.

We are in the habit of regarding polyps rather lightly, and perhaps I was not as careful as I should have been. Of course they may be a manifestation of malignancy, and one should also consider meningioma.

DISCUSSION

DR. SAMUEL SALINGER: Did the x-ray show any involvement of the sinuses, or was there anything peculiar about the tumor so far as its vascularity was concerned?

DR. ALFRED LEWY: There was nothing to make us suspicious of anything except ethmoiditis and an ordinary polyp.

Twitching of Facial Muscles Following Radical Operation of the Mastoid

M. TAMARI, M. D.

(This paper appears in full on page 675.)

DISCUSSION

DR. M. A. GLATT: In this case a left-sided radical mastoid operation was performed because of the presence of a cholesteatoma. Two months later when the patient had symptoms of labyrinthitis and recurrence of suppuration in the ear upon which the operation had been performed, twitching of the facial muscles was noted. This was undoubtedly due to the facial nerve being exposed postoperatively because of continuation of the pathologic process in the middle ear. A similar case is now under observation on my service at the Infirmary, with signs of the presence of a labyrinthine fistula, with fine twitching of some of the facial muscles upon application of pressure over the tragus and the use of compressed air in the external canal. A simple mastoid operation was performed two years previously and there has since been recurrence of the discharge.

These cases raise the question of the effect on the nerve when the canal is uncovered. It appears that during a long-standing suppurative process the nerve sheath develops a protective mechanism. Should the nerve be accidentally exposed, however, it is likely to be injured. I have seen two cases where one centimeter of the descending portion of the facial nerve was found bare and embedded in the cholesteatoma. In each, there was a fistula of the external semicircular canal and loss of sinal and dural plates. In neither was there a history of preoperative or postoperative paralysis. In one of these cases I was able to demonstrate twitching of the face by mild pressure on the nerve with a probe through the ear canal.

Exposure of the nerve because of its anomalous position is rare in the normally developed organ. It should be remembered that a radical mastoid operation is essentially an attico-antrotomy and that it is not necessary to proceed at first with the simple mastoid technic. Exposure of the attic will invariably lead to the antrum even in difficult cases. One should guard against too low excavation under the external bony canal in searching for the mastoid antrum, mistaking an eroded semicircular canal for the mastoid cortex, sharp curettage of the tympanic cavity, especially along the posterior portion of the annulus. Caution should also be stressed in the use of caustics or

punch forceps on granulation tissue along the area of the facial nerve, without first testing for a labyrinthine fistula or an exposed nerve.

Congenital Atresia of the External Auditory Meatus

GEORGE H. WOODRUFF, M. D.

JOLIET, ILL.

(Abstract)

This patient, a man aged 22, was first seen on June 29, 1942. He had been refused for military service because of a congenital deformity of the right ear, consisting of a microtic, deformed pinna with absence of the external auditory meatus. No bony canal could be palpated. There was noticeable facial asymmetry, part of which was due to partial paralysis of the right facial nerve. This asymmetry the patient said had been present as long as he could remember. It was probably in part also due to the absence of the bony canal wall, the condyle of the mandible on this side resting against the anterior wall of the mastoid process. His hearing, as reported by the Induction Board and also the Infirmary, was spoken voice at six feet. The left ear was normal.

The x-ray report was as follows: "Examination of the mastoid and the external auditory canal shows an undeveloped mastoid triangle with a hard density increase about the external auditory meatus, extending over the canal region. The findings in the mastoid suggested an old chronic postinflammatory change; this is not definite, since the parts are poorly developed. The fact of there being no opening in the external auditory canal points to additional lack of development, which would suggest a congenital atretic basis."

Although it seemed doubtful that the hearing could be improved, it was decided to try surgery. A curved incision was made along the superior and posterior attachments of the flabby, irregularly shaped fold of soft tissue which served as a rudimentary pinna. The periosteum was elevated forward to the glenoid fossa; no trace of a bony meatus was found. The solid bone behind the fossa was removed until the antrum was opened, revealing mastoid cells, some of which were opened. The horizontal semicircular canal was exposed, but no trace of a tympanic membrane was found nor were any ossicles exposed. The newly created bony canal was smoothed off with a bur. An opening was made in the soft tissue space between the rudimentary

tragus and the remainder of the malformed pinna. A large Thiersch graft was cut from the upper arm, wrapped around a split rubber tube and introduced into the newly created canal. The posterior incision was tightly closed.

On the ninth day when the tube was removed, the graft was found to have taken well everywhere except at the external opening where a portion of it was loose. The important part of the aftercare was keeping the external opening dilated. This was accomplished by the insertion of sterile cotton tampons, changed daily. The patient was discharged 18 days after operation.

At the present time the auditory meatus appears to be adequate in size and the cavity is lined with epithelium. Some exfoliated material gathers in the depths, as in all radical cavities, but has not been particularly troublesome. The patient's hearing has definitely improved. It is now ten feet for the spoken voice, and from six inches to one foot for the whispered voice. He is not able to qualify for military service, but is contentedly employed in a defense manufacturing plant.

The patient consulted a plastic surgeon about reconstruction of the auricle but was advised that a better cosmetic result could be obtained with a prosthesis; so far, he has been contented with things as they are.

DISCUSSION

Dr. E. J. Blonder: I would like to ask Dr. Salinger whether the prosthesis or plastic surgery would be most satisfactory in this case.

Dr. Samuel Salinger: I think this patient has enough tissue to warrant plastic reconstruction rather than prosthesis. We do not usually advise a prosthesis unless the auricle is at least three-fourths destroyed. Here there seems to be a considerable amount of skin and cartilage which could without doubt be expanded. I have seen eight or ten cases similar to this, and the patients always ask if construction of an auditory canal will improve the hearing. Invariably my reply is in the negative; I do not see how hearing can be improved unless the canal can be made to extend to the tympanomastoid air space; Usually the only reason for performing the operation is cosmetic. I should like to ask Dr. Woodruff whether the canal he constructed leads into the excavated mastoid cavity.

Dr. Glenn Greenwood: What was the audiometric curve on this case?

DR. ALFRED LEWY: Was the good ear masked when the hearing tests were made?

DR. GEORGE WOODRUFF (closing): We have an audiogram which was made a few days ago. Unfortunately none was made prior to operation, although they are usually made routinely. I did not discover this omission until several weeks later.

In answer to Dr. Salinger, the artificially made canal very definitely extends directly to the antrum. The horizontal semicircular canal was widely visualized and the antrum was thoroughly exposed. Dr. Busby, one of our residents, made the interesting discovery that during inflation of the eustachian tube the anterior canal wall bulged backward into the lumen.

The other ear was masked when the whispered voice test was made.

MASSACHUSETTS EYE AND EAR INFIRMARY

MOSHER LABORATORY

Clinical Meeting of December 2, 1942

DR. LEROY A. SCHALL, PRESIDING

The Thymus Problem

DISCUSSION

DR. L. A. SCHALL: At the suggestion of Dr. Allan M. Butler, Head of the Department of Pediatrics, we are devoting this hour to the discussion of the thymus problem. We realize that the thymus problem is far from being settled. We realize, too, there may not be a thymus problem. I believe I am the only one in this room that has seen a death that could be called a thymic death.

In 1924 or it may have been in 1925, the maid in the Throat Clinic asked me to see her five-year-old nephew who was scheduled to have his tonsils removed. I talked with him, then went with him to the operating room and joked with him while the anesthetist began to administer gas-oxygen anesthesia.

The youngster was not scared, nor was he crying. After several inhalations of nitrous-oxide-oxygen anesthesia, he stopped breathing. We thought he was merely holding his breath, but after holding the jaw forward, then pulling the tongue to insure a free airway, then applying artificial respiration, then in desperation, performing a tracheotomy, we could not get him to breathe again. At no time was he cyanotic—the death was more a picture of shock. The Medical Examiner, Dr. McGrath, performed an autopsy and, finding an enlarged thymus gland and generalized lymphatic hypertrophies, called the death one due to status lymphaticus.

Anyone who has gone through such an experience, anyone who must explain to the parents such a tragedy, will not pass off lightly this question.

I have assembled an imposing list of expert witnesses, both pro and con. I hope that there will be no punches pulled. May I invite Dr. Mosher to open the discussion because it was this case that I

watched that prompted Dr. Mosher to carry out his studies on the thymus.

DR. HARRIS P. MOSHER: Mr. Chairman, Ladies, and Gentlemen: I suppose I am on this program for historical reasons, not that I am as yet an historical figure. This is the nearest to an assemblage of the Supreme Court that I have ever attended. Looking at this list of names, I see there are a number of new brooms. New brooms are supposed to sweep clean; anyway, they always kick up a lot of dust.

I came here hoping for enlightenment. If I get it, it will be very satisfactory to me. I should like to start off by asking the prosecution if they will tell me what a thymic death is, what status lymphaticus is, what the thymus gland does. It is about time, if science moves as rapidly as some scientists think it does, that we should have some knowledge about the thymus comparable to what we have about the pituitary, the thyroid and the adrenals.

Historically, my interest in the thymus started in 1924, or 1925. We had a run in the short time of six months, of four sudden deaths under ether, which on autopsy were called thymic deaths. If anyone has had to explain to a parent the cause of a sudden death of this kind he will not envy any one's having four such interviews. The head of the hospital does not like this performance either.

We started to look up the literature on the subject, to go over our x-ray films, in order to see what we could find to help us in this problem. The question was whether it was a piece of hard luck or whether there was something in this thymic death business. We began making routine x-ray examinations of the thymus.

We found it was easy to get the size of the thymus, that is, if you have a good x-ray film. An out-of-town x-ray film very often amounts to little, and even given a good one, it requires an experienced interpreter to tell whether the thymus is enlarged or not.

We took preoperative x-ray films of all cases, and when an enlarged thymus was found, according to Dr. Macmillan, it was irradiated four times. The thymus came down to normal, and the operation was then carried out. The majority of the cases were tonsils and adenoids. We did this for two years and had no deaths. Then our studies were written up.

The conclusion we came to was this: That where an enlarged thymus was shown by x-ray examination the patient was in the potential tragedy class. First the upper age limit for taking x-ray films was 16 years, then 12. We have been taking preoperative x-ray films,

as I said, since 1924, and have had no more tragedies except in three cases which to my mind were exceptions which proved the rule. In one case the x-ray film taken was sent over to the Massachusetts General Hospital for interpretation and was reported negative. This patient died a thymic death. Autopsy showed an enlarged thymus and adenopathy of the intestinal glands. The other two cases Dr. Macmillan will speak of. We still feel we do not dare stop the preoperative x-ray examinations.

About seven years ago I took the matter up with Dr. Macmillan, because I knew we were standing almost alone. Some of the other hospitals in the city did not follow us. Our stand even met with derision.

The summary of the literature brought out that these sudden deaths were very comparable to a death by acidosis. There was also a question of histamine poisoning. All animal experimentation up to that time, pre- and postnasal, had proved negative.

I have said repeatedly that whenever anybody, by science or by luck, can tell me how to pick out a potential tragedy case in any cheaper way than by taking an x-ray film and finding an enlarged thymus, I am ready to adopt his method. It is my hope that with this panel we will get some light on such a method, although frankly I don't expect to.

It has been brought up against this procedure that it is expensive. The expense here is five dollars. I never knew a funeral to cost as little as five dollars.

Now about the derision our procedure has created—some years ago Dr. Morse, who was a very positive gentleman, short and Napoleonic in stature, and Cock Robin in manner, read a paper on the "Thymus Obsession." He delivered it in Newton, poked fun at us and put in the phrase that what we need in medicine is honesty. It so happened that while he was talking a tonsillectomy patient died a thymic death in Newton.

DR. L. A. SCHALL: Associated with Dr. Mosher in this early investigation was Dr. A. S. Macmillan, and he has taken x-ray films of some 52,000 children for a suspiciously enlarged thymus. Will you carry on the discussion?

DR. A. S. MACMILLAN: In 1924 when we started this we had two deaths. X-ray films were made of the bodies before they went to autopsy. When Dr. Mallory opened the chest of one of them the thymus gland was found to extend above the heart and to overlie

the heart gland. Thus we were able to confirm it as being an enlarged thymus. In the other case, when the chest was opened the thymus was found to extend over the heart. The patients were over six years of age.

Dr. Mosher wanted to know about the x-ray investigation of the thymus and for that purpose he obtained the body of a baby who died at birth at another hospital and opened it. The film was taken before the chest was opened and it showed a very prominent supracardiac shadow and the normal heart shadow below it. Then he collected some of the babies dead at birth. From the casts he made one can see a large thymus gland overlying the heart, hanging down like an apron over the cardiac outline. In another, the gland hangs down over the cardiac outline giving a superior mediastinal shadow.

When we got a child with a superior mediastinal shadow we called that an enlarged thymus and those children received some x-ray treatment and if the picture shows a postradiation shadow, we diagnose these as suspicious thymus.

There was another case on the opththalmological service. They had been treating children up to eight and ten years of age and they decided it was interfering with their work and stopped it. Within a week they had a patient die a sudden death which was unexplained, and those three patients are the only ones that died since we started.

DR. L. A. SCHALL: What percentage of our cases have a suspicious thymus?

DR. A. S. MACMILLAN: Three or four per cent have a suspicious thymus and are treated as such.

DR. L. A. SCHALL: Dr. P. F. Butler, Roentgenologist of the Boston City Hospital, will carry on the discussion.

DR. P. F. BUTLER: At the City Hospital we tabulated at one time all the chest cases passing through the x-ray department for ten years. We had some 6000 cases for thymic study and 13 unexplainable deaths. Dr. Leary did complete autopsies to determine the causes of death. He found only some general enlargement of the lymphatics, particularly in the intestinal tract. He felt that, in the absence of other causes, they were probably thymic deaths, but agreed that he lacked complete evidence.

I believe the name applied by Dr. Mosher to these cases is a very important one—"potential casualties." We should try to make a diagnosis before operation. This calls for very careful investigation

and interpretation of the films. The films should always be taken in the upright positions, a film on deep inspiration and one on deep expiration, and one lateral view. If the thymic shadow persists in all positions, if in the lateral view it is enlarged and the trachea is pushed backward or compressed, we cannot rule out a large thymus. The trachea in a very young child is as collapsible as a thin rubber ball and, according to Jackson, can be very easily compressed. On the other hand we have repeatedly seen chests with wide supracardiac shadows in children who have already been operated on without casualties.

It is a rule at the City Hospital that all children up to *nine* years of age must have a film study before operation to rule out an enlarged thymus. I don't quite agree with the age limit. I should like to see it at five or six. It is generally at this age that the thymus reaches its maximum. It is not active, however, after five years of age. If we find a large supracardiac shadow the patient is given x-ray treatment before operation. It requires little treatment, a total of 80 r units in two treatments 48 hours apart; no harm is done, and it is not a hardship to give it. We have often seen a definite diminution in size in the supracardiac shadow following these treatments.

The two problems we have are: (1) in newborn children who have respiratory difficulty and (2) in sudden deaths following operation or shock. In the newborn children, these respiratory difficulties may be explained by other postnatal causes in the lung or heart, rather than the thymus. The sudden deaths are the problems which bother us most.

Our average cost per case for irradiating a patient in the hospital is $2.20, surely not a prohibitive amount. It also gives a further feeling of security if the patient is shown to have a negative chest. Nearly every doctor who is having his child operated on likes to have an x-ray plate of the chest made before having the tonsils out.

I am inclined to follow Dr. Mosher and continue as we are doing but I would agree to have the age limits lowered to the sixth birthday instead of the ninth.

DR. L. A. SCHALL: So far we have had the expert testimony for the defense. Now comes the prosecution which Dr. Allen M. Butler opens.

DR. ALLEN M. BUTLER: I cannot carry this discussion on in terms of my own experience as I really have none. My interest in the problem arose from the house officers who are checking the medi-

cal aspects here before operation, calling attention to the inconvenience to the patients and the parents in our practice of taking routine thymus plates. They got together a number of cases which illustrated this inconvenience. I have these today. Then I inquired concerning the present consensus of the justification of taking routine thymus plates and have here today some of the people, at Dr. Schall's request, to express an opinion.

Then I looked up the literature very sketchily. I am sure no one in this room questions the existence of large thymuses in children and no one questions the ability to reduce the size of the thymus by irradiation. The question is, are these normal thymuses observed in healthy children the cause of the anesthesia deaths? I would like in a few minutes, if I could, to read a few excerpts from the literature.

In 1926 the Medical Research Council and Pathologists of Great Britain formed a committee to collect information on a large scale for the purpose of numerous studies to find other causes of the unexplained deaths when the only apparent abnormality was the problem of a large thymus.

In 1931 Young and Turnbull presented the reports made by Hanover in the early part of 1920 in which he said an abnormally large thymus in itself cannot be considered to be the indication of status lymphaticus when no obvious cause of death is found at postmortem examination, and again it was the opinion of the committee that the facts elicited in the present inquiry are in harmony with those of Hanover and Greenwood showing no evidence of so-called status thymolymphaticus as a pathological entity.

Another very careful study was made and reported in 1932 by Boyd in Canada, who states briefly that these mortality findings agree with those which showed that the largest thymuses occurred in healthy children who died suddenly by accident, and I think that explains the feeling of a good many pathologists previous to these studies, which were all made in the twenties, that the finding of a large thymus was not the cause of sudden death because a well child had a normal healthy enlarged thymus, whereas the sick child was a sick child who had a small thymus. Dr. Garland some years ago wrote on thymic death and his concluding statement was that the present rule of irradiating all cases in which a shadow appears would seem unjustifiable.

Dr. Mahoney of the Children's Hospital, in going over the data from the records of 16,000 cases from 1930-1934, found 225 deaths or 1.4%, with autopsy made in 70%; but he was unable to find a

death which could be attributed to the thymus. Another physician inquiring into 11,000 tonsillectomies in his institution, stated that there were no thymic deaths and no preoperative treatments.

Dr. John Morse in a review says the following: "There is no proof that enlargement of the thymus is a factor in the complication described as status lymphaticus. It doesn't seem either reasonable or justified to say that an x-ray film should be taken of every patient before operation."

Dr. Sidney Farber of the Children's Hospital states "There has been no instance of what might be called status thymolymphaticus in well over 3000 autopsies in this laboratory," and he believes there is no justification for the diagnosis of thymic death or status thymolymphaticus that can be found.

It is of interest in these cases that the diagnosis of thymic death is very often made without benefit of postmortem examination. After autopsy when this diagnosis is made it is made by mistake, made by the size of the normal thymus.

In the last 2000 community autopsies they were unable to find a pathological thymus or a thymus with definite symptoms during the life of the patient. In a series of ten cases the weight of the thymus was 26-65 gr. In these cases no symptoms were noted during life.

There are many pathologists who believe there is no justification for the diagnosis of status lymphaticus and that the cause of death must be elsewhere in the body. I believe that I may state with fairness this diagnosis is made all too freely. This problem is far from solved.

I requested Dr. Alan Moritz to answer the following questions: (1) Are preoperative thymus plates justifiable? Answer: No. (2) Is the diagnosis of status thymolymphaticus as a cause of sudden death justifiable? Answer: No. (3) Can a hospital be held responsible for negligence in a case of sudden death if a preoperative thymus plate has not been taken? Answer: There is no statutory clause to that effect. (4) Do you think the continuation of the practice of taking preoperative plates at the Massachusetts Eye and Ear Infirmary contributes to the continuation of this practice elsewhere? Answer: Yes, because the practice of the Massachusetts Eye and Ear Infirmary can be used as the practice of an important institution and thus can be used to imply the probable negligence against others in not taking thymus plates.

DR. L. A. SCHALL: Dr. Farber could not be with us, but he has sent a worthy representative in Dr. Robert Gross.

DR. ROBERT GROSS: The opponents would rather leave us with the impression that their patients have died because they had an enlarged thymus. It is a well-known fact that a child who dies suddenly will have a big thymus—whether the death be because of accident, anesthesia, overwhelming infection or any other condition which proves to be fatal before the thymus can involute. Hence, if a child dies quickly—from any cause—the finding of a large thymus should not be construed to mean that the patient died *because* of this organ.

At the Children's Hospital we give approximately 4000 general anesthesias a year on the surgical and orthopedic service, 1000 a year in the Out-Patient Department, 900-1000 in the Private Ward—a total of about 6000 per year. These include nitrous-oxide-oxygen, ether, and avertin-ether anesthesias. We have carefully studied our records of the last two decades and have had no "thymic deaths." Of course, we have had sudden deaths during operations. But when a complete autopsy is done and the search is exhaustive, the pathologist has always found an adequate cause for the exitus. Dr. Sidney Farber has emphasized the importance of overwhelming bacteremias or other infections—the presence of which was often unsuspected before death. In short, during the last 20 years we have not had a single individual who was known to have died from an enlarged thymus. Hence, we have been forced to believe that there is no such entity as a "thymic death."

DR. L. A. SCHALL: Several times in this discussion these sudden deaths have been called "anesthesia deaths." Dr. Beecher, are you willing to accept the blame, that they are due to anesthesia?

DR. H. K. BEECHER: It seems to me we are dealing with an entity that has not been *proven* to have caused any death. I have kept track of anesthesia deaths for a certain number of years and it is true that wherever anesthesia has been improved the number of mysterious deaths decreases. I believe that a good many of the "thymus death" cases may be explained on the simpler basis of poor anesthesia. I don't believe failure to find an adequate presumptive cause of death is an adequate basis for saying that an enlarged thymus is the cause of death. The statement that nothing was lost by taking these thymus plates impresses me. However, there are differences of opinion as to that. Suppose the average cost is only two dollars. When an institution like the Massachusetts Eye and Ear Infirmary follows that practice, many other institutions may well follow suit

and the total cost is not negligible. In conclusion, it is my observation that the giving of the anesthetic plays a large part in these mysterious deaths, and a larger and more skillful body of hospital anesthetists may go far to solve this problem.

DR. L. A. SCHALL: We have now reached the autopsy room, and our expert witness is Dr. Tracy B. Mallory.

DR. T. B. MALLORY: If there is any such thing as status thymic lymphaticus it is an extremely rare disease, in which the experiences of any one pathologist are not likely to be great enough to solve the problem. Where large masses of material have been collected, such as Dr. Butler quoted from the National Pathological Society of Great Britain, the consensus is that there is nothing in the idea of status thymic lymphaticus. At the last meeting of the American Association of Pathologists and Bacteriologists a man with considerable medico-legal experience reported on a large series of sudden deaths which came to him as medical examiner. In some 22 out of 50 cases where the autopsy was done reasonably soon after death and it was possible to do satisfactory cultural studies, he found there was postmortem evidence of septicemia. He could not find any case he was prepared to classify as due to status thymic lymphaticus. Among the assembled pathologists there was not one who expressed a dissenting view. Many spoke up to agree with him, that if a thorough autopsy plus good bacteriological work and appropriate laboratory tests are done it is rarely necessary even to consider status lymphaticus.

I have seen a number of sudden deaths under anesthesia in adult individuals, without persistent thymus tissue, cases that were symptomatically exactly like the cases that have been described in infants and children. I class those as anesthesia deaths. In almost every case it has been possible to find some gross error in connection with the anesthesia. I am glad that Dr. Beecher spoke as he did because this diagnosis of status thymic lymphaticus is a convenient way to let the anesthetist out but personally I think the anesthetists kill the patients.

DR. L. A. SCHALL: I am glad to see in our audience another expert pathologist, Dr. Shields Warren.

DR. SHIELDS WARREN: I very rarely come in contact with children's cases. However, I do have a great many instances of enlarged thymus in adults. As you know we get a lot of thyroid cases over at the Palmer Memorial Hospital. In that particular group with enlarged thymus I can recall no instance of sudden death. We have

microscopic proof of the enlarged gland. My experience in talking with pathologists in different parts of the country has exactly paralleled Dr. Mallory's, in that when a diagnosis of status lymphaticus is made as a cause of death, it is frequently because somebody is trying to be kind either to somebody in the operating room or to the anesthetist.

DR. L. A. SCHALL: A physician of large experience, particularly in infectious diseases, in charge of the South Department of the Boston City Hospital, can, I know add to this discussion—Dr. Place.

DR. EDWIN H. PLACE: I have seen cases occur in the group that have obstruction to breathing; several were observed which were due to the thymus and I recall very well one patient that came to the Massachusetts General Hospital with marked obstruction to breathing. We intubated the patient. Putting the tube in did not relieve her at all. We stopped and looked at her and found she had an expiratory obstruction. Dr. D. C. Greene did a bronchoscopy. She died on the table with the bronchoscope in. The autopsy showed marked enlargement of the thymus and thyroid gland and it was diagnosed as a thymic death. Cases like that we see once in a while. There was one girl whose story was gradually increasing obstruction. She was given antitoxin. It did not help her at all.

One point I think worth mentioning. I disagree that the trachea in children is easily compressed. One tumor finally did compress the trachea but in that case the tumor was very large. It must have been there for a long period before. The trachea is elastic and suddenly will compress but I don't believe a large thymus can compress the trachea. I must say that I see cases I cannot explain any other way than that they have a marked enlargement of the thymus. I don't think the thing is as easily explained as even the pathologists' efforts seem to do.

DR. L. A. SCHALL: I will repeat what I said at the beginning of this discussion. I saw a five-year-old youngster die, and I am convinced that the death was not due to the anesthesia. Of course, neither I nor anyone else can prove that it was not due to the anesthesia.

Dr. McGrath, the medical examiner, called the death a thymic one. The term status thymolymphaticus may be a convenient one to cover our ignorance, but our problem, as Chief of an active hospital service, is the prevention of death, avoidable or otherwise. Will Dr. Mosher sum up his reaction to the discussion?

DR. H. P. MOSHER: First about Dr. Macmillan. He doesn't speak of enlarged thymus as shown by the x-ray plate. He calls it a suspicious thymus. The age limit is ten years. Then comes Dr. Butler. He quotes Dr. Leary. Dr. Leary is still undecided about thymic deaths, as to what they are, and he is a pathologist. He must be the only pathologist in the country who is undecided on the question of thymic death, but he always has his own opinion and a good reason for it. Dr. Butler wants the age limit reduced to five. Dr. Macmillan, do you agree to that?

DR. A. S. MACMILLAN: Deaths have occurred at the ages of five and six.

DR. H. P. MOSHER: Dr. Butler says one man sees all normal thymuses as large by x-ray examination. Why does Dr. Macmillan find only three per cent of apparently normal children with enlarged thymus?

Dr. Allen M. Butler, our new consultant, said he knew nothing about the subject from experience. He then quoted the literature at great length. He brushed aside the tragedies we have had. He said the English pathologists take no stock in this. They disagree with us. I have some British in-laws and they seldom agree with me. So this objection does not worry me.

Dr. Gross was extremely positive. He spoke of the chicken and the egg. The Children's Hospital has been our chief opponent in this matter and much derision of us has come from there. I have a feeling that if a house officer or anyone in the Children's Hospital should take a preoperative x-ray plate he would lose his job.

About the Infirmary being an example to others around the country—I am pleased that it is. Dr. Butler tells us they follow our procedure in the Boston City Hospital.

Dr. Moritz does not believe in status lymphaticus but does not tell us what it is. To the question, is an x-ray examination worth while, he said no. Is the hospital liable? Suppose the hospital is sued. The hospital itself is all right; it is the Chief of Staff that stands the suit. If a case should occur and a suit be started, a clever lawyer for the prosecution could make a good case for himself and for half the damages should the verdict be in his favor by asking the question "Was a preoperative x-ray plate taken?" I think that someone can be held liable if a preoperative x-ray plate is not taken. Dr. Moritz feels the same way.

Dr. Warren sees only adult cases. It interested me that the thymus can be large in connection with the thyroid disease. There is a connection here the pathologists have not worked out.

Dr. Mallory thinks status lymphaticus is very rare and that we are going to find septicemia back of these cases. I wonder whether our bacteriology is perfect enough to find these septicemias in all cases before they come to operation. Dr. Mallory feels that if you hunt long enough you will find sufficient cause for the sudden death. Some of the sudden deaths are anesthetic deaths.

To sum up—the three unexplained cases of so-called thymic deaths which we have had have not been explained—all were cases of sudden death where the thymus was large. The large thymus was the only hint that these cases were in the potential tragedy class. I am frank to say I have gotten very little new light on this subject today and I stand where I was at the beginning of this hour.

A so-called enlarged thymus is a potential tragedy case. As long as we can have this knowledge and the pathologists at Children's or any other hospital cannot give us a better hint that we may be in for trouble, I feel like continuing the procedure.

Abstracts of Current Articles

NOSE

Some Aspects of Symptomatology and Treatment of Sinusitis.
Barroilhet, Juan, Rev. de Otorrinolaring. 2:148 (March), 1943.

The author outlines his methods of diagnosing and treating diseases of the sinuses: Diagnosis begins with a thorough history of the case, which is one of the most important features of complete examination. Anterior and posterior rhinoscopy yield such valuable information that it must be meticulously performed. Transillumination is important and especially valuable in detecting sinusitis without frank symptomatology. A motor-driven vacuum apparatus is used for mass aspiration which is very helpful for detection of discharge from the ethmoid cells and the frontal sinuses. This has not been of value in diagnosing conditions of the maxillary sinuses. He has repeatedly washed large quantities of purulent exudates from the antra after failing to withdraw any at all by suction.

Aspirated material is of three types: The exudate from an acute "catarrh" of fifteen to twenty days' duration is mucopurulent. A yellow or brick-red exudate is characteristic of empyema. The most common type of exudate obtained is one which separates into two layers. The lower one is composed of thick, yellowish, opalescent material. Above this there is a suspension of numerous gray flocculi.

Although aspiration is helpful in treatment, he considers it not curative but of greatest value in diagnosis. He particularly stresses its diagnostic value in cases which have a history of frequent colds and postnasal drip, in which rhinoscopy shows only a little congestion and transillumination is negative.

In the author's experience pathology may be present in the antra even though the usual methods of examination, including x-ray, fail to confirm it. In such instances antroscopy may show a variety of definite pathological areas in the mucosa. This method of examination is the one which provides final and unequivocal data for diagnosis.

Acute sinusitis is treated by rest in bed and inhalations and sprays which will reduce congestion and permit drainage through the ostia of the sinuses. During the sub-acute stage he practices aspiration and applies heat by means of Bruning's light box. Chronic conditions are

treated surgically. For the chronic maxillary antrum he prefers the Caldwell-Luc operation. In chronic infections of the frontal and sphenoid sinuses and in ethmoiditis, the external approach following the technique of Ferris Smith is advocated.

Sulfonamide therapy has been of no value in chronic, although it may be helpful in acute, conditions. The sulfonamides may, however, prove deceptive in masking the progress of the disease; and the author stresses close observation during their administration.

HIGBEE.

Thrombophlebitis of Cavernous Sinus.

Grunwald, E. S., Rev. de Otorrinolaring. 2:161 (March), 1943.

Thrombophlebitis of the cavernous sinus most frequently begins in localized staphylococcus infection about the vestibule of the upper lip, eyelid, cheek, or forehead. The progress of the infection occurs through a circumscribed thrombophlebitis which precedes abscess formation. Extension of the infection progresses through the superior or inferior ophthalmic veins. These unite to form the ophthalmic vein which empties directly into the cavernous sinus. During the period in which the reaction of tissues is toward circumscribing the infection, any attempt to establish drainage surgically is dangerous. The manipulations of the patient himself in an effort to squeeze out the pus are often the direct cause of its extension to the cavernous sinus.

The author describes anterior, lateral, and posterior venous channels which carry the infection to the sinus. The anterior pathway is the superior or inferior ophthalmic vein which drains the area of the nose, upper lip, check, forehead, and eyelid. In addition to these structures he mentions suppurations of the frontal sinus and infected hematoma of the nasal septum. The lateral route of transmission is the pterygoid plexus which drains the area of the tonsils, pharynx, alveolar processes, and mouth. This plexus enters the cavernous sinus through the foramen ovale. Five cases of this type are mentioned. Two followed streptococcal pharyngitis, one resulted from infection of the pharyngomaxillary space following tonsillectomy, and two followed extractions of teeth. The posterior pathway is through the superior and inferior petrosal sinuses. Two cases of such infection are reported. One was caused by an acute exacerbation of chronic otitis media; the other was due to peritonsillar abscess which progressed to thrombosis of the internal jugular vein.

The signs of cavernous sinus thrombophlebitis are edema of the eyelids, chemosis of the bulbar conjunctiva, exophthalmos, and ophthalmoplegia. The general symptoms are those of septicemia. The fever curve depends on the circulation around the area of phlebitis or thrombosis. If circulation is not obstructed, constant drainage will induce continuous high temperature; but if thrombosis is complete, a fluctuating temperature with chills following the peaks will prevail.

Sulfonamide therapy has considerably altered the prognosis. The author reports six cases with a mortality of one hundred per cent occurring before sulfonamides were available. Since that time he is able to report five cases with a mortality of forty per cent.

A review of the various surgical procedures is given, but all are disappointing to this author who believes the key to prevention is noninterference, and chemotherapy the most promising treatment.

HIGBEE.

On Rhinoliths.

Polson, C. J., J. Laryngol. and Otol., 58:79 (March), 1943.

This very complete essay begins with a historical review, a definition and a discussion of the incidence of rhinoliths. Their occurrence, structure and measurements are exhaustively discussed. Among the exogenous nuclei the author mentions small fruit stones, sunflower seeds, beads, buttons and other small objects. Among the endogenous nuclei teeth are the most frequently encountered. Sequestra and dried blood clots are seen but these are rare. Dried nasal secretion has been suggested as a nucleus but the author regards this as unlikely, since crusts are common in the nose and rhinoliths very rare. Pathogenesis, diagnosis and treatment are discussed, and a bibliography of fifteen pages is appended.

PHARYNX

The Mechanism of Swallowing.

Negus, V. E., J. Laryngol. and Otol., 58:46 (Feb.), 1943.

After a discussion of the methods of swallowing in certain of the lower animals, the author describes what he characterizes as the three stages of swallowing in man: 1.) the buccal stage, 2.) the pharyngeal stage, and 3.) the esophageal stage. The effect of the

various structures, particularly the musculature, is described. Special emphasis is given to the closure of the larynx in deglutition to protect the airway during the passage of food and to the cricopharyngeal sphincter at the mouth of the esophagus to keep the gullet closed in order to avoid the entrance of air into the esophagus during respiration.

Malignant Melanoma of Tonsil and Fauces.

Howarth, Walter, J. Laryngol. and Otol., 58:29 (Jan.), 1943.

The author describes the case of a woman who was first seen with diffuse and extensive pigmentation of the fauces and palate. The condition remained practically stationary for two years, at which time raised lobulated plaques appeared. Because of the widespread distribution of the lesion, x-ray therapy was tried but a full and intensive course had little effect upon it. The main mass of the tumor which occupied the region of the tonsil was then excised with a diathermic knife. A year later a tiny spot in the opposite tonsillar fossa began to grow and this was also excised. At the time of the report, a year later, the tonsil regions were scarred and the diffuse pigmentation of the palate remained as before. The patient had no pain or discomfort.

TRACHEA

Traumatic Rupture of the Trachea

Maturana, Ernesto, Rev. de Otorrinolaring. 2:113 (Dec.), 1942.

In this article there is a report of two cases of traumatic rupture of the intrathoracic trachea. Both cases terminated fatally, and autopsies were performed in each one.

The first case was that of a laborer, 27 years of age, who fell a distance of three meters. When found shortly after the accident dyspnea and cyanosis were present, and also an area of bilateral emphysema extending from the zygomas to the pelvis.

Treatment consisted of sulfapyridine, cardiac stimulation, and pleural tappings which gave relief for eight days. Following this period there was a serious relapse. Eight hundred cubic centimeters of air were aspirated from the pleura. This gave a considerable amount of relief. On the thirtieth day subglottic edema developed which re-

quired tracheotomy. The patient died on the thirty-sixth day. Autopsy showed obliteration of the trachea by stricture two and one-half centimeters above the carina. There was no fracture of the ribs.

The second case was a six-year-old child who was run over by a cart. There was immediate dyspnea, cyanosis, and emphysema extending over the thorax and the head. Death occurred in forty minutes. Autopsy showed the left bronchus completely separated from the trachea. There was no fracture of the ribs.

HIGBEE.

ESOPHAGUS

Stricture of the Esophagus Caused by Caustics

Grez, Anibal, Rev. de Otorrinolaring. 2:94 (Dec.), 1942.

Lesions resulting from caustics may vary from superficial erosions to deep ulcerations extending the whole length of the esophagus.

Fluoroscopic examination is the first diagnostic procedure and will reveal the location, extent, and depth of the area involved. Endoscopy is deferred until the third week because of the danger of instrumental trauma which may produce hemorrhage, abscess, or perforation and mediastinitis.

The author finds complete stenosis very rare; usually even severe burns will permit passage of a small bougie.

Gastrostomy is performed on the fourth or fifth day on those patients who cannot be fed by mouth and show dehydration. If injury to the stomach prevents gastrostomy, a jejunostomy is advocated.

Strictures due to caustics do not ordinarily reach their maximum extent in less than a few months, but when caused by acids they may reduce the lumen to filiform size within two or three weeks. The treatment is dilatation by endoscopic technique when bougies can be passed, but retrograde dilatation is employed to filiform stricture. During each treatment two or three bougies of successive sizes are used, each remaining in place twenty minutes. Retrograde dilatation may, if begun early, calibrate the esophagus in six months.

HIGBEE.

Congenital Atresia of the Esophagus: Report of Four Cases.

Chont, L. K., and Starry, L. J., Radiology 40:169 (Feb.), 1943.

Essential findings of four cases of congenital atresia of the esophagus are discussed. The chief diagnostic features are the clinical history and the radiographic pattern of the esophagus following swallowing of lipiodol. All of these cases had a tracheo-esophageal fistula. Embryology and treatment are discussed.

JORSTAD.

EAR

Advances in the Study of Hearing.

Ormerod, F. C., J. Laryngol. and Otol. 58:1 (Jan.), 1943.

This is a brief review of recent work in the physiology of hearing. The physics of motion of the tympanic membrane, as described by Wilska and by Lindsay and his associates, is recounted. This is followed by a discussion of the nature of movement of the ossicular chain and the intratympanic muscles. The old controversy regarding the relative function and importance of the two windows is brought up to date. The author gives credence to the work of Stevens and Davies and of Hughson and Crowe, which point to the greater importance of the oval window in the hearing function, and adduces as evidence the work of Hallpike and Scott, who occluded the round window of cats with plaster of Paris and found no loss of electrical response to aural stimuli. Fatigue localization, sound intensity and phase are also briefly discussed.

The Electrical Reactions of the Cochlea and Auditory Nerve.

Adrian, E. D., J. Laryngol. and Otol., 58:15 (Jan.), 1943.

This article begins with a review of the Wever and Bray phenomenon discovered in 1930 and the clarification of the nature of impulses set up in the cochlea by Hallowell Davis. The fact that cochlear potentials, amplified and reproduced as sound, constitute an accurate duplicate of the sound waves which have fallen on the ear demonstrates that there is a structure in the inner ear which reacts faithfully to air vibrations over the audible frequency range. The threshold of sound required to produce a detectible electrical effect in the cat corresponds closely to that in man. It has been pointed out that

the cochlear potentials persist even though the auditory nerve has been damaged to an extent which would cause deafness, but no hearing has ever been demonstrated when there is a failure of the cochlear effect. The cochlear effect, therefore, has its inception in the receptor mechanism of the inner ear.

The remainder of the article is largely a description of the work of Walzl and Bordley at Johns Hopkins, and Galambos and Davis at Harvard.

The author suggests somewhat unconvincingly that it is probable that we may recognize smells in the same way, by the pattern they throw on the olfactory area.

Pneumococcus Mucosus Otitis in Diabetes.

Bisi, Humberto, Rev. de Otorrinolaring. 2:125 (Dec.), 1942.

Acute otitis in the diabetic patient is considered as an inflammation of all pneumatic spaces of the temporal bone. For some years past all otitis media has been considered a condition actually involving the mastoid antrum and the adjacent cells. Recent histological studies, however, reveal that all cells of the temporal bone participate in the reaction.

In general, while supporting the opinion of most clinicians that mucosus infection may be very deceptive, the author states that diabetes does not tend to increase this hazard and that insulin has completely reversed the former unfavorable prognosis in this condition.

Cases of mucosus otitis which present no evidence of mastoiditis or other complications are treated with large doses of sulfanilamide while the regimen of insulin and diet control is carried on.

Complications of mastoid infection, such as thrombophlebitis, extradural abscess, and meningitis are anticipated previous to actual clinical signs by the inability of insulin and a properly calculated diet to overcome hyperglycemia. These complications may appear very late in the disease, and for this reason all such patients should be watched for months and receive adequate surgical intervention whenever hyperglycemia and leukocytosis persist. The lateral sinus should be exposed widely and explored for a possible thrombus even in the absence of symptoms of this condition. General anesthesia is absolutely forbidden because of its tendency to induce acidosis and acute hepatic insufficiency. Otherwise there are no contraindications for

surgery referable to the diabetic condition, provided this is adequately treated.

HIGBEE.

Vertigo of Ménière's Syndrome.

Asenjo, A., and Riesco, J. S., Rev. de Otorrinolaring. 2:83 (Dec.), 1942.

These authors recognize four clinical types, as follows:

1. Ménière's disease as originally described by Ménière; 2. Vertigo related to systemic disease or tumors of the central nervous system; 3. Ménière's pseudo-syndrome in which vertigo is present without evidence of abnormal function of the eighth nerve; 4. Ménière's syndrome with vertigo, tinnitus, and deafness.

Eighteen cases were treated medically, with good results in twelve. In three cases the nerve was sectioned after the method of Dandy and good results attained in all of them.

In all cases except those in which tumor was diagnosed, they recommended four to six months medical treatment and advised surgery only after failure of this regimen.

HIGBEE.

Otitis Media and Mastoiditis in Children, A Survey of 1,992 Cases.

DeSanctis, A. G., Larkin, V. de P., with the assistance of Gougelman, W. A., J. A. M. A. 120:1087 (Dec. 5), 1942.

This is a statistical study of the results of chemotherapy in the treatment of otitis media and mastoiditis in children. This study is presented in seven graphs and eight tables with discussion.

The apparent decrease in mastoiditis is shown to be due to the use of sulfonamides. 1992 admissions to the New York Post-Graduate Hospital in the years 1931 to 1941 inclusive were tabulated and graphed as to incidence according to age, monthly variation, blood studies, bacteriological studies, symptoms, and types of treatment. This shows that, though the total number of cases varies from year to year and has decreased somewhat more in the last two years than before, the severity of the disease as indicated by symptoms, blood count, and cultures has remained fairly constant. Beginning with 1936 the percentage of cases of otitis media has decreased rapidly; that is, in 1931 to 1938 the ratio of purulent acute otitis media to acute mastoiditis approximated 2 or 3 to 1; in 1941 the ratio was 15 to 1.

During the past four years there were 162 patients who received adequate sulfonamide therapy, 15 of whom (9%) developed mastoiditis and required mastoidectomy. In the same period there were 506 patients with similar conditions who were treated in the usual way but without sulfonamides, 156 (30%) of whom developed acute mastoiditis and required mastoidectomy. In 1942 sixty patients were treated (half with sulfathiazole and half with sulfadiazine); there were only two cases of mastoiditis, and they received sulfadiazine.

The routine of the sulfonamide treatment at present is to give the patient sulfathiazole shortly after admission to the hospital—the dosage being 1 grain per pound of body weight in a 24-hour period, divided into six equal doses. This dosage is continued for 4 days after the temperature has returned to normal or 2 days after aural discharge has ceased. Then two-thirds of the original dose is given until the ear drum has approximated a normal appearance. The sulfonamides are given for a minimum of 7 days and usually not longer than 14 days.

BRYAN.

MISCELLANEOUS

A New Material for Plastic Surgery.

Cardoso, A. D., Rev. Brasileira de Oto-Rino-Laring. 10:319 (May-June), 1942.

To overcome the many difficulties attendant upon securing suitable animal tissue, such as cartilage and bone for inclusions in plastic surgery, the author experimented with the synthetic resin known as Vinilite.

Individual tolerance for the substance was tested by the implantation of Vinilite into the arm of five patients, all of whom showed no untoward reaction. The material was removed at intervals varying from 22 to 98 days. The local reaction of the tissues was studied. In one instance after a period of 90 days a fibrous capsule with slight inflammatory reaction was found, but in all others the tissue showed no evidence of intolerance.

Nasal plastic surgery was performed in two cases. In the first case the inclusion was successful, and after 87 days there had been no reaction. In the second case the material was covered by a flap from the arm which failed to take, and the operation was unsuccessful.

The material was kept stored in alcohol and taken out at time of operation. It can also be sterilized by boiling for one minute.

The author claims many advantages for Vinilite. Pieces of the material can be fused by the addition of acetone in which it is soluble. It can be moulded or cut to any size or shape after being softened by immersion in hot water. In comparison with an autogenous cartilage graft, he cites the advantage of a single operation and freedom from subsequent distortion and the difficulty of keeping stored cartilage in suitable condition.

HIGBEE.

Unusual Case of Carcinoma of Both Lungs Associated with Lipoid Pneumonia.
Wood, E. H., Jr., Radiology 40:193 (Feb.), 1943.

This 50-year-old lady used oily nose drops in large quantities intermittently for ten years. She expectorated one to two pints of whitish, milky sputum daily during the last two weeks before death. Postmortem examination revealed bilateral alveolar carcinoma of the lung with lipoid pneumonia. Clinical symptoms, physical, radiographic, and autopsy findings are presented.

JORSTAD.

Influence of Thiamine On Induced Hyperthyroidism.
Williams, R. D., and Kendall, E. C., Arch. Int. Med. 72:185 (Aug.), 1943.

The authors have noted that patients who developed tachycardia, restlessness and apprehension of a degree which necessitated discontinuance of thyroid administration tolerated the drug if they were previously given thiamine hydrochloride. The thiamine, apparently, had no effect on the increase in the metabolic rate and in the cardiac rate. Experiments were conducted upon two physically healthy women. "The rates which decreased irregularly during deprivation of thiamine rose to consistently high levels when thiamine hydrochloride was again provided, no other change having been made in the regimen." The authors regard this as an indication that thyroid hormone is less effective for the maintenance of metabolic processes during thiamine deficiency.

Books Received

Allergy Anaphylaxis and Immunotherapy.

Basic Principles and Practice. By Bret Ratner, M. D., Clinical Professor of Pediatrics, New York University College of Medicine; Visiting Pediatrician and Director of Pediatrics, Sea View Hospital; Associate Attending, Children's Medical Service, Bellevue Hospital; Consultant Pediatrician, French Hospital. Pp. xi+834, illustrated, with tables and bibliography. Baltimore, The Williams & Wilkins Company, 1943. (Price $8.50.)

This is one of the most satisfying texts it has been our privilege to examine. The author has set down with careful attention to detail the whole fundamental pattern of allergy and has later developed it to encompass the more specific ramifications of serum sickness, food allergy and drug allergy.

The monograph is divided into three sections: I. The Principles and Practice of Immunotherapy, II. Allergy to Immunotherapeutic Agents, and III. The Allergic State.

The author has used for his foundation the phenomenon of serum allergy on the basis that it can be more comprehensively studied than asthma, eczema, food allergy, or some of the other allergic manifestations. It can be studied more or less at will from its incidence to its termination and the material available is unlimited.

Fifty-six pages are devoted to a bibliography. It seems a pity that having devoted so much space and effort to this fine collection of references the titles should have been omitted. While this would have doubled the length of the list, in this reviewer's opinion it would have been well worth the space since it would have been of general value to the research worker instead of being merely a source of the references in this text.

There is little, if anything, in the book which bears directly upon otolaryngological problems. However, the allergic reactions of the respiratory tract are among the most obtrusive conditions with which we have to deal and this book invites our careful scrutiny.

Primer of Allergy.

A Guidebook for Those Who Must Find Their Way Through the Mazes of This Strange and Tantalizing State. By Warren T. Vaughan, M. S., M. D., Richmond, Virginia, with illustrations by John P. Tillery. Second edition. Pp. 176, with 26 illustrations. St. Louis, The C. V. Mosby Company, 1943.

At the other end of the gamut is this *Primer of Allergy*, characterized by its author as, "A guidebook for those who must find their way through the mazes of this strange and tantalizing state." This small book is keyed down to the comic strip mentality (Who shall say that this does not include all of us?) and requires the reader to find his way not only "through the mazes of this strange and tantalizing state" but through a heterogeneous collection of cartoons, phantasmagoria and quiz games.

One marvels that a mind which could encompass such a sentence as, "The major allergics, those comprising the ten per cent of the population previously mentioned, those possessing heavy allergic inheritance, not only become sensitized to occasional substances but also to substances in their daily or regular environment, such as wheat, eggs, milk, beef, coffee, house dust, feathers, orris root and the like" should be content to play its way through the cartoons and the pretty pictures to find out about allergy.

But the author guessed better than the reviewer, for this is a second edition.

Textbook of the Ear, Nose, and Throat.

By Francis L. Lederer, B.Sc., M.D., F.A.C.S., Professor and Head of Department of Laryngology, Rhinology and Otology, University of Illinois College of Medicine, Chicago; Chief of the Otolaryngological Service, Research and Educational Hospital; and Abraham R. Hollender, M.D., F.A.C.S., Assistant Professor of Laryngology, Rhinology and Otology, University of Illinois College of Medicine, Chicago. Pp. xi+595, with 170 illustrations. Philadelphia, F. A. Davis Company, 1942. (Price $6.00.)

This book is essentially a rearrangement and condensation of previous Lederer texts. The material is more concisely set down, the number of illustrations reduced, and the chapters arranged so that he who runs—or fights—may read.

Carrying out the tabloid idea, the authors have resorted to a sort of literary capsule at the beginning of each chapter. This consists of a terse paragraph set in a box and more or less happily termed a "preview."

This volume, which is attractively bound, takes a place midway between the familiar continental compendiums and the standard textbook. It is somewhat less complete than the latter but far ahead of the former in scope and usefulness.

Acute Infections of the Mediastinum.

By Harold Neuhof, M.D., D.S., F.A.C.S., Clinical Professor of Surgery, Columbia University, College of Physicians, Surgeon to Mt. Sinai Hospital; and Edward E. Jemerin, M.D., D.S., F.A.C.S., Associate Attending Surgeon Sydenham Hospital, Adjunct Surgeon Beth David Hospital, Senior Clinical Assistant in Surgery and Research Assistant, Mt. Sinai Hospital. Pp. vii+407, with 154 illustrations and 42 tables. Baltimore, The Williams & Wilkins Company, 1943. (Price $6.00.)

This monograph should be of some practical interest to laryngologists and especially to endoscopists.

Following a short review of the literature, the authors present a series of one hundred cases, minutely described, with a summary and commentary on each. In almost every case roentgenograms are reproduced and there is a profusion of explanatory line drawings. The cases are grouped relative to their etiology in four categories: those secondary to trauma of the esophagus, to upper respiratory infection, to infection of the lung or pleura, and to miscellaneous factors. There follows a section dealing with the anatomical and pathological background and two others devoted to clinical and therapeutic considerations.

Geriatric Medicine.

Diagnosis and Management of Disease in the Aging and in the Aged. Edited by Edward J. Stieglitz, M.S., M.D., F.A.C.P., Consultant in Gerontology, National Institute in Health; Visiting Physician Medical Service, Baltimore City Hospitals; Attending Physician, Washington Home for Incurables, Washington, D. C. Pp. xix+887, with illustrations and tables. Philadelphia, W. B. Saunders Company, 1943.

A comprehensive textbook, the work of fifty-four collaborators, ably edited, on a subject vital to nearly every one in the practice of medicine.

Particularly engaging are the first one hundred pages which deal with the general subject of aging and the tissue changes which accompany it.

Since "it will not be long before one-third of the whole population of the United States will be over fifty years of age," this book invites attention.

Notices

ASSOCIATION OF MILITARY SURGEONS

The Association of Military Surgeons of the United States will hold its Fifty-First Annual Meeting at The Bellevue-Stratford Hotel, Philadelphia, beginning October 21, 1943. The President is Rear Admiral William L. Mann, M. C., of Seattle, Washington.

GRADUATE COURSE IN OTOLARYNGOLOGY

The University of Cincinnati College of Medicine offers its Seventh Annual Graduate Course in Otolaryngological Surgery on the Cadaver on October 4 through October 9, 1943. Kindly address all communications to The Dean, College of Medicine, Eden and Bethesda Aves., Cincinnati, 19, Ohio.

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